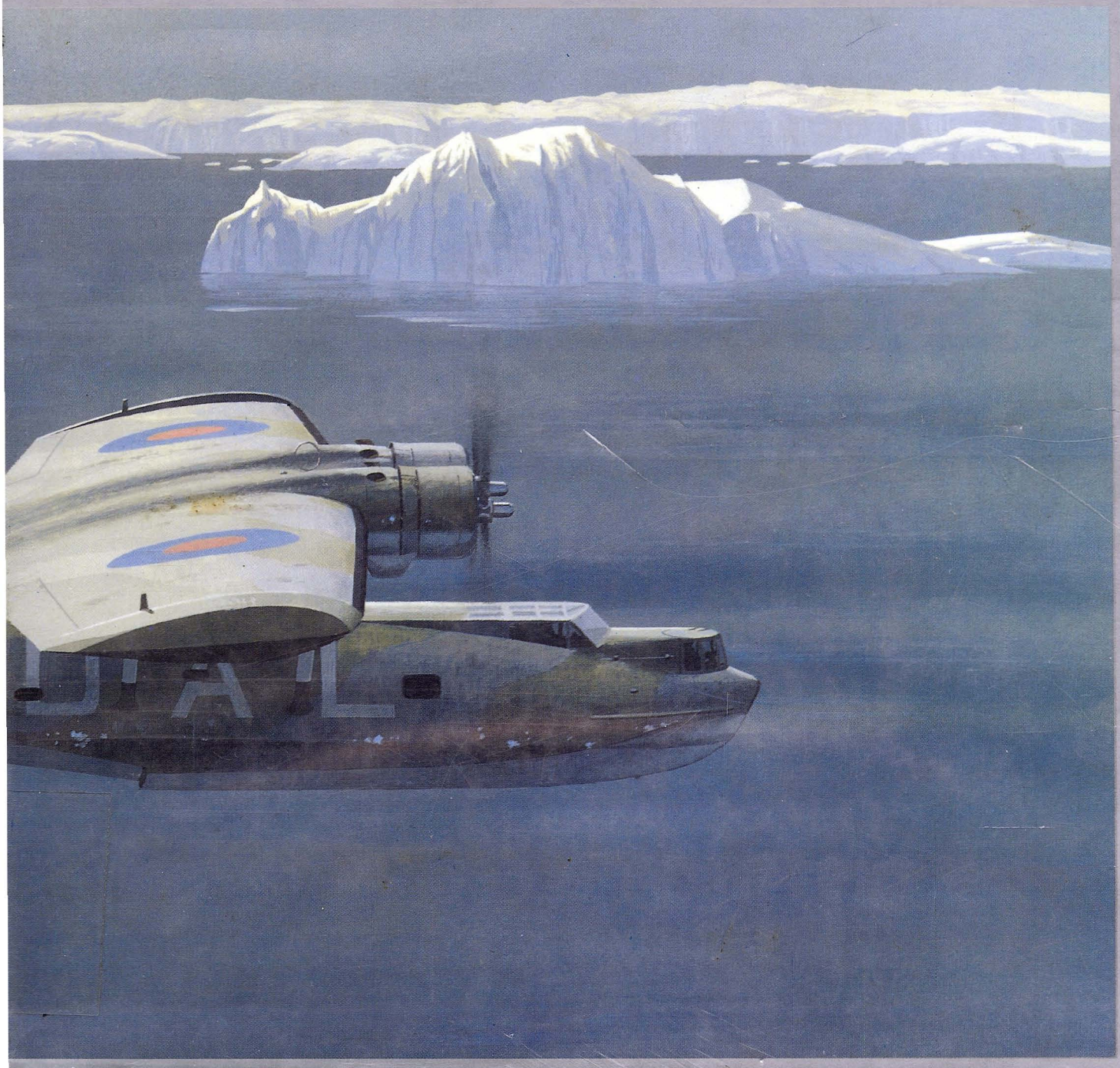
PUTNAM

General Dynamics Aircraft

and their Predecessors

John Wegg



General Dynamics

The AFTI/F-16 (75–750) at Fort Worth in 1982. (General Dynamics)

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Preface and Acknowledgements

Of all the major aircraft manufacturers active in the United States today, none has had such a complicated corporate history as General Dynamics. The present General Dynamics is a defence conglomerate encompassing not only aircraft (which contribute about one third of its revenue), but also submarines, missiles, space and electronics, and land vehicles and systems.

As its title suggests, this book restricts its coverage to aircraft, and other products of General Dynamics are excluded. However, there are three aircraft manufacturers that are eligible for inclusion in this volume but have had to be omitted because of space considerations. Canadair, owned outright by the Electric Boat Company (forerunner of General Dynamics) since July 1947, became Canadian-controlled in 1976, and is comprehensively covered in a companion Putnam, *Canadian Aircraft since 1909*. Also included in that title is Fleet Aircraft of Canada, formed to produce the Consolidated Model 14 under licence. The other omitted company is Cessna Aircraft, acquired by General Dynamics in 1985. Clyde Cessna's aircraft manufacturing career dates back to 1911 and since 1927, the number of types produced by his company and the sheer volume of production almost demands a separate volume in the Putnam aircraft manufacturer series.

These three deliberate pretermissions have not lessened the need for a different approach to that followed by other titles in this series, as the remaining ten companies produced over one hundred basic types, a staggering array of sub-types, and a combined total production figure in excess of 62,000 aircraft. Further complicating the format was the intricate family tree of the predecessor companies, themselves frequently the subjects of takeovers, mergers, and acquisitions.

Therefore, this book is divided into four separate parts which more logically follow the progress of aircraft design and manufacturing by the ten companies, although inevitably there is some overlap and some anomalies. The quartet consists of the Consolidated lineage, encompassing Thomas and Thomas-Morse, Dayton Wright, Consolidated, and Hall Aluminum; the Vultee group of companies—Stinson, Vultee, and Barkley-Grow; the Convair or Consolidated Vultee era; and finally General Dynamics. Each of these sections include histories of the manufacturers themselves, followed by the aircraft types and, unlike other Putnam titles, which use appendices, selected projects and production information.

With such a vast subject, there have been limits to the exhaustiveness of detail that can be included. Therefore, although attempting to remain close to the Putnam tradition of thoroughness with regard to historical and technical facts, some aircraft type histories have been subject to editing by the author, along with licence production of other unrelated manufacturer's types. Also, the sections referring to unbuilt projects and production lists have been intentionally restricted in scope. As the main focus has been to record the history of aircraft, similar sacrifices have been made with regard to the fullness of corporate history and biographies of founders and key figures. In the latter case, two previously published works are of considerable value: *Reuben Fleet and the story of Consolidated Aircraft*, by William Wagner (Aero Publishers, 1976), and John Underwood's *The Stinsons* (Heritage Press, 1967).

Any attempt to chronicle the more than one hundred basic types produced and built by the ten companies included in this book faces the problem that after so many corporate changes since 1910, a great deal of contemporary source material and photographs are now either in inaccessible storage, or lost. General Dynamics itself does not have a company historian, although attempts at gathering information were made at various times by its employees. Howard O Welty and Nelson Fuller authored a multi-part series about the history of Convair/General Dynamics in the in-house publication *Convairiety* in the late 1950s, and a company-sponsored public relations exercise called *Dynamic America* appeared in 1958.

Another company-sponsored historical review appeared in 1973, to commemorate the fiftieth anniversary of the Convair Aerospace Division of General Dynamics. Written by Jack Smothers, much material was contributed by Gordon Jackson, acknowledged as the unofficial historian of Convair. Fortunately, a great deal of Jackson's notes, gathered over a long period with help from Larry Peterson, from company archives, photographs, and through interviews with employees has survived and are now with the San Diego Aerospace Museum. This fine establishment, which has risen phoenix-like from the ashes of the disastrous fire that almost totally destroyed the previous collection, is a haven of refuge for Consolidated and

Convair material. Through the kind offices of Ray Wagner, archivist, and his staff, the museum's collection was opened to the author and proved to be an indispensable source.

Although this book was not sponsored by General Dynamics, Jack Isabel and Z Joe Thornton, public affairs managers at San Diego and Fort Worth respectively, assisted with photographs and information wherever possible. I am also indebted to several former Convair employees for reading and correcting parts of my manuscript thanks to their firsthand knowledge, namely William F Chana (flight test engineer), Donald P Germeraad, John W Knebel, and B J Long (test pilots).

Many fellow historians, often experts on a particular subject in their own right, unselfishly shared their files of documentation and photographs with me. My heartfelt thanks to Richard Sanders Allen, Harold M Andrews, Walter J Boyne, Dustin W Carter, Jean-Pierre Dubois, René Francillon, Robert A Gordon, Terry Judge, Gary L Killion, Robert E Martin, Alain Pelletier, and Patrick Vinot Prefontaine. Others offered advice, assistance, research sources, information, and photographs that all added to this volume, and my grateful acknowledgements go to James J Davilla, H S Fyfield Jr, Harvey Lippincott, Leonard E Opdycke, J J Paul, Jim Presley (Naval Air Museum), Boardman C Reed, and Michael J Strok.

As the former Convair photograph files are no longer intact or accessible, the majority of the illustrations had to be culled from a variety of collections, including the author's. Every attempt has been made to credit the original photographer but regrettably, over the passage of time, many names have been lost and my apologies to those slighted by an incorrect credit line. Special thanks to Peter M. Bowers, Stephen J. Hudek, and A R Krieger for access to their vast negative collections, and also to Richard Aardsma, G James Alaback, Larry Milberry, Merle C Olmsted, and Robert J Ruffle, all of whom provided illustrations.

Published sources of particular value were volumes of the *American Aviation Historical Society Journal, Convairiety, Stinson Plane News, Stinson Plane Talk*, and *The Vultair*; plus notable books by Allen Blue (*B-24 Liberator*), Gary L Killion (*The Convair Twins*), Jay Miller (*Convair B-58)*, and Ray Wagner (*American Combat Planes*).

Most of the general arrangements drawings were produced by Carl G Ahremark, whose skill and care is evident to all. Gratitude also goes to Conway Maritime's editor John Stroud, not only for his shrewd comments and corrections, but also for his knowledgeable writing over many years which inspired this author down the path of aviation journalism.

JOHN WEGG
California, 1990

Author's Notes

In general, style and presentation of facts in this book follows along the accepted lines of the Putnam manufacturer series. The most obvious deviation concerns the use of the term Manufacturer's Serial Number (msn) instead of the hitherto accepted style, in enthusiast circles at least, of Constructor's Number (c/n). Aircraft manufacturers assign an individual serial number to their products as a means of identification, a number that is rarely changed (if so, then most often in rebuilding projects) and thus, unlike numbers or letter combinations issued by registration authorities, or military serial numbers, form a permanent record. Consequently, the history of a particular aircraft may be traced via this number. Manufacturer's Serial Number, commonly abbreviated to just serial number, is the accepted form used in the industry in the United States and other countries, although some companies use the variation Factory or Airframe Serial Number.

However, in an attempt to avoid confusion with military serial numbers, the enthusiast movement, apparently originating with that in the United Kingdom in the immediate post-Second World War years, adopted the use of 'c/n' which quickly spread worldwide and into publications of all standards. Unfortunately, 'constructor's number' itself is ambiguous because manufacturers often have other numbering systems in use besides the serial number sequence, such as line numbers, fuselage numbers, and customer numbers. In some cases, the line number is far more important during production and for subsequent record keeping by the manufacturer than the serial number. However, the latter is the number stamped on the data plate attached to the aircraft.

Therefore, as the manufacturers in this book are American, the decision has been made to break with an arguably unsound tradition and use the industry-accepted form. Military serial numbers are shown in parentheses, with USAF examples prefixed by the fiscal year of allocation, and Navy serials with BuA (Bureau of Aeronautics) or BuA-, the latter denoting that the serial was prefixed by the letter A. The majority of the General Dynamics group of companies allocated a new sequence of manufacturer's serial numbers, start ing at one, for each type built. An exception was Vultee, which issued numbers sequentially from the V1 until the V12 (1 to 144), then changed to blocks of numbers for each type.

Certain designation styles used in this book may be another issue for some readers, particularly with regard to the Convair civil transports and the Vultee models. Although an abbreviation used within the company, C-V or CV (Consolidated Vultee) has never appeared as part of an aircraft model designation. Whilst the use of CV-240 etc (but note that Convair CV-240 would be redundant) is perhaps admissible, it should be stressed that the official model is Convair 240, appearing thus on the aircraft type certificate. Convair-Liner has also appeared in various forms, but this is the copyrighted style used by Convair and which appears on the individual aircraft data plate. In a similar vein, it should be noted that Convair 880 and Convair 990 are promotional designations, the official designations being Convair 22/22M, and Convair 30/30A on the type certificate. In the case of Vultee, the style V1-A, V11-GBT, V12-D etc was that used by the company itself, although official documents of other agencies frequently show alternative presentations.

Abbreviations

As with any specialised subject, the aviation world is peppered with a host of abbreviations and acronyms. Some will be familiar, others not, thus a list of those appearing in this work follows .

AAB	Army Air Base
AB	Air Base
ADC	Air Defense Command
AFB	Air Force Base
AFRES	Air Force Reserve
AFSC	Air Force Systems Command
AMRAAM	Advanced Medium Range Air-to-Air Missile
ANG	Air National Guard
ANGB	Air National Guard Base
APSA	Aerolíneas Peruanas SA
APU	Auxiliary Power Unit
ASR	Air-Sea Rescue
ASV	Air-to-Surface-Vessel
ASW	Anti-Submarine Warfare
ATC	Approved Type Certificate
AVENSA	Aerovías Venezolanas SA
BG	Bomb Group
BG (H)	Bomb Group (Heavy)
BW	Bomb Wing
BOAC	British Overseas Airways Corporation
BuA	Bureau of Aeronautics (Navy)

CAA	Civil Aeronautics Administration
CAC	Consolidated Aircraft Corporation
CASA	Construcciones Aeronauticas SA (Spain)
CAT	Civil Air Transport (Taiwan)
CATC	Central Air Transport Corp
CCTS	Combat Crew Training Squadron
CIA	Central Intelligence Agency
CIC	Commander-in-Chief
CNAC	China National Aviation Corporation
CPAL	Canadian Pacific Air Lines
CSW	Combat Support Wing
DBF	Destroyed By Fire
del	Delivered
DEWS	Distant Early Warning
ECM	Electronic Counter Measures
ECS	Electronic Countermeasures Squadron
ECW	Electronic Countermeasures Wing
ELINT	Electronic Intelligence
Esk	Eskadrille (Danish)
FAA	Federal Aviation Agency
FAMA	Flota Aérea Mercante Argentina
FICON	Fighter Conveyor
FIS	Fighter Interceptor Squadron
FLIR	Forward-Looking Infra-Red
FY	Fiscal Year (USA)
HAL	Hindustan Aircraft Ltd
HUD	Head Up Display
IPTN	Industri Pesawat Terbang Nurtanio (Nurtanio Aircraft Industry Ltd, Indonesia)
JAL	Japan Air Lines
JAT	Jugoslovenski Aerotransport
JATO	Jet-Assisted Take-Off
KLM	Koninklijke Luchtvaart Maatschappij voor Nederland en Kolonien (Royal Dutch Airlines)
KNILM	Koninklijke Nederlandsch-Indische Luchtvaart Maatschappij
LACSA	Líneas Aéreas Costarricenses
LAPE	Líneas Aéreas Postales Españolas
LTC	Limited Type Certificate
MATS	Military Air Transport Service
NACA	National Advisory Committee for Aeronautics
NAAS	Naval Auxiliary Air Station
NAF	Naval Air Facility
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NASM	National Air and Space Museum
NATC	Naval Air Test Center
NATO	North Atlantic Treaty Organisation
NATS	Naval Air Transport Service
NEIF	Netherlands East Indies Air Force
NTU	Not Taken Up
OCU	Operational Conversion Unit
PACAF	Pacific Air Force (USAF)
PMTC	Pacific Missile Test Center
QANTAS	Queensland and Northern Territory Aerial Services
RAAF	Royal Australian Air Force
RAF	Royal Air Force
RAI	Reseau Aérien Interinsulaire
RCAF	Royal Canadian Air Force
REAL	Redes Estaduais Aéreas Ltda
Reg	Registration/registered
RNZAF	Royal New Zealand Air Force
RoKAF	Republic of Korea Air Force
SAAB	Svenska Aeroplan Aktiebolag
SABCA	Société Anonyme Belge de Constructions Aéronautiques
SABENA	Société Anonyme Belge d'Exploitation de la Navigation Aérienne
SAC	Strategic Air Command
SAM	Surface-to-Air Missile
SANA	Sociedad Argentina de Navegación Aérea
SAS	Scandinavian Airlines System
SATA	Société Anonyme de Transports Aérien
Skv	Skvadron (Norway)
Sm	Smaldeel (Belgium)
SOC	Struck Off Charge
SONACA	Société Nationale de Construction Aérospatiale SA (Belgium)
STC	Supplemental Type Certificate
STOL	Short Take-Off and Landing
TAA	Trans-Australia Airlines
TAC	Tactical Air Command
TACA	Transportes Aéreos Centro-Americanos
TAM	Transportes Aéreos Militares (Peru)
TC	Type Certificate
TEAL	Tasman Empire Airways Ltd
TFG	Tactical Fighter Group
TFS	Tactical Fighter Squadron
TFW	Tactical Fighter Wing
TRAPAS	Société Français de Transports Aériens du Pacific Sud
TUSAS	Türk Uçak Sanayii Anonim Ortakligi (Turkish Aircraft Industries Inc)
TWA	Trans World Airlines
USAAC	United States Army Air Corps (effective 2 July, 1926)
USAAF	United States Army Air Forces (effective 20 June, 1941)
USAAS	United States Army Air Service (effective 20 May, 1918)
USAF	United States Air Force (effective 18 September, 1947)
USAFE	United States Air Force Europe
USCG	United States Coast Guard
USN	United States Navy
VIASA	Vías Internacionales Aéreas SA
VP	Patrol Squadron (US Navy)
VPB	Patrol Bomber Squadron (US Navy)
VTOL	Vertical Take-off and Landing
WFU	Withdrawn From Use
WO	Written Off
WRS	Weather Reconnaissance Squadron

Thomas Brothers and Thomas-Morse

William T Thomas, founder of the aircraft company that bore his name, graduated from the Central Technical College, South Kensington, in 1908 at the age of 22, and finding suitable employment elusive in his native country, emigrated to the United States. Thomas was a motorcycle enthusiast and had worked on gas engines during a pre-college apprenticeship with the British Westinghouse Manufacturing Company. After arriving in New York, Thomas was hired in the drafting room at the Herring-Curtiss Company at Hammondsport. Glenn Curtiss was holder of the world's motorcycle speed record, a builder of famous racing engines, and an avid promotor of flying. Thomas made drawings for the *Golden Flyer* and its four-cylinder 40hp engine and for the *Red Devil* biplane on behalf of Capt Thomas A Baldwin.

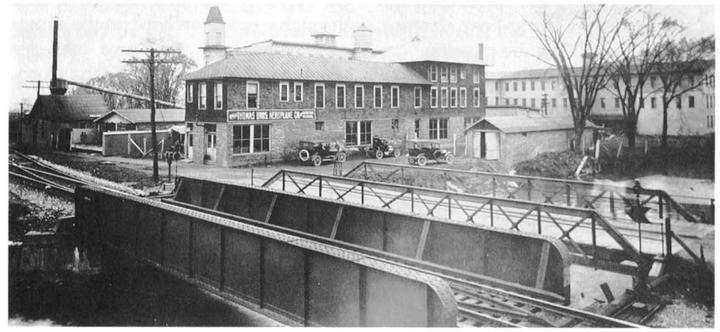
Intent on designing and building his own aircraft, Thomas left Curtiss and obtained the use of a barn at Hammondsport owned by the Roulette Wine Company and began work in November 1909, assisted by Bert Chambers, a Herring-Curtiss motorcycle mechanic. Thomas did business as Thomas Brothers Company, although his brother, Oliver W, did not arrive from England until several months later.

The first aircraft, a two-seater pusher biplane powered by a 22hp Kirkham automobile engine, was completed the following spring and flown by Chambers from Page Farm, Hornell, New York, to where the shop had moved that winter. Thomas himself started flying in June 1910. Later that year, the company moved to Bath, New York, and soon grew to eight or ten employees.

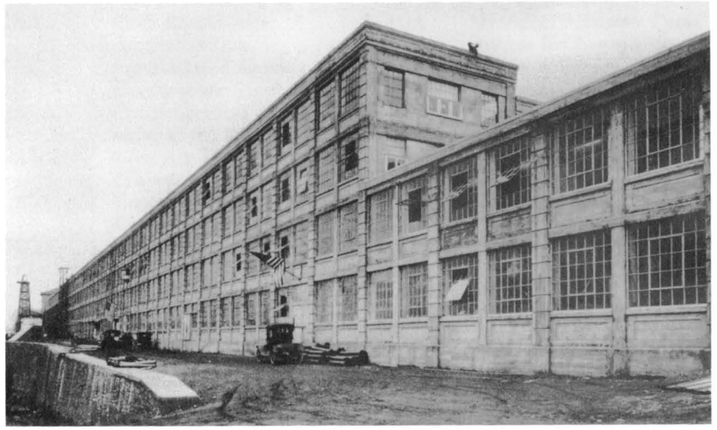
A rare photograph of the two key unrelated Thomases from Britain. On the left is designer B Douglas Thomas, on the right is William T Thomas who founded the Thomas Brothers Company in 1909. (Randolph F Hall)

An improved model of the first aircraft, the Thomas TA, was completed which won several races and both biplanes were used for exhibition flying to provide some income. The Thomas School of Aviation Inc opened in 1912, the first certificated by the Board of Regents in New York State. An early graduate, Frank H Burnside, became chief company pilot and flew the Thomas E pusher to 13,000ft in 1913, claiming a new United States record. That year, the company was incorporated as the Thomas Brothers Aeroplane Company with William as president and Oliver as vice-president. Work continued on new pusher designs, and also a single-seat monoplane was tried without success, and two wooden-hulled flying-boats were tested. Experiencing leaks in the hulls, the brothers experimented with metal covering, one of the earliest uses of metal for aircraft structure undertaken in the USA.

Late in 1914, Benjamin Douglas Thomas (no relation but also from England) joined the Thomas brothers at Bath. B Douglas Thomas had grad-



The original building rented in 1914 by the Thomas Aeroplane Company in Brindley Street, Ithaca, New York, which became knows as the Inlet Plant. It still stands today. (Harold Andrews collection)



After its reorganisation as the Thomas-Morse Aircraft Corporation in 1917, the company's main plant was on South Hill, Ithaca, attached to the Morse Chain Company's building. (Aircraft Year Book)

More 'Tommy Scouts' were built than any other Thomas-Morse type and it was the most famous American aircraft of the First World War, even though it took no part in the conflict. This is an S-4B in 1918-style US Army Air Service markings. (Peter M Bowers collection)

uated from King's College, London, worked for Vickers and then the Sopwith Aviation Company. In May 1914, Glenn Curtiss had invited him to the United States following a visit to the Kingston factory. Before his departure from England, Thomas designed the Model J for Curtiss and at Hammondsport Thomas assisted with the design of the Model H flying-boat *America*, intended for an Atlantic crossing.

Thomas was initially unsalaried, but worked under an agreement whereby he would supervise construction and receive half of any profits, and he started immediately on a tractor design, designated T-2, using his experience with the Curtiss Model J. On 7 December, 1914, another move was undertaken, this time to Ithaca, New York. The Thomases had been induced by an attractive offer by the local board of trade, a year's free rent on a three-storey building in Brindley Street. This later became known as the Inlet Plant. Designer A V 'Fred' Verville also joined the company during this period. A flying school was set up on one of the country's earliest municipal airports, an earth runway carved through a peach orchard on the shores of Cayuga Lake, and was used for training Royal Canadian Flying Corps pilots during the war.

The T-2 flew soon after the company arrived at Ithaca and was considered one of the best aircraft of its day. A British Admiralty purchasing commission ordered twenty-four T-2s but further contracts were not forthcoming, reportedly because of a shortage of Curtiss OX-5 engines. The possibility of adapting the British Green engine was explored but a solution was found by obtaining the services of George H Abel and Harold N Bliss and forming the Thomas Aeromotor Company on 5 August, 1915. Abel and Bliss had designed an engine at the BF Sturtevant Company, Boston, and had an agreement whereby if opportunities existed elsewhere, they and the engine design were free to move on.

A new tractor design, the D-2, was initially powered by a 135hp Sturtevant, then by the near twin Thomas 8, an adaptation of the Sturtevant eight-cylinder water-cooled engine. In 1915, Frank Burnside flew a D-2 at 97.4mph and claimed a new world speed record. Several similar aircraft were ordered by the US Navy and Army.

With the MB-3, Thomas-Morse had the chance to obtain a major US Army contact which would have guaranteed it a postwar role as a major manufacturer. However, through competitive bidding, Boeing obtained the order for the improved MB-3A and Thomas-Morse turned its attention to the less lucrative task of developing all-metal designs. (Harold Andrews collection)

However, although the war had brought some orders, the Thomas concern required additional funding to remain in business, leading, on 31 January, 1917, to the organisation of the Thomas-Morse Aircraft Corporation with the Morse Chain Company of Ithaca paying off all debts, advancing working capital and taking control as sole shareholder. Principal stockholders in the new company were Herman H Westinghouse, of the air brake family, and J F Miller, president of the Union Switch and Signal Company. Frank L Morse, of the parent company headed the new corporation and William Thomas was named vice-president and general manager. B Douglas Thomas continued as chief engineer but Oliver moved to the Dayton Wright Company and after the war managed family cattle interests in Argentina, where he died in 1947.

A new concrete extension was built to the Morse Chain Company plant on South Hill, Ithaca, and the Inlet Plant was retained for sub-assembly. In addition, an experimental shop was set up in a former corset factory on Center Street. The S-4 'Tommy Scout' trainer won Army approval and by October 1917, the company had a backlog of one million dollars, including orders for one hundred S-4s at $5,400 each, twelve SH-4s for the Navy at $7,575 each, and a quantity of Thomas-Morse engines. At peak production in 1918, the Ithaca plants employed 1,200 workers and three test pilots, Frank Burnside, R C 'Tex' Marshall and Paul D Wilson. When Burnside left the company in 1920, Wilson took over as chief pilot until 1928.

Although affected by post-Armistice contract cancellations, the company followed on the success of the S-4 with the compact MB-3 designed around the 300hp Hispano engine. A

After seven years of unsuccessful all-metal aircraft design, Thomas-Morse finally achieved a breakthrough with the O-19 series. However, the company was sold to Consolidated before work on the production models started and the vast majority of O-19s, including the O-19B illustrated, was built at Buffalo by Reuben Fleet's company.

production contract order for fifty was placed in 1919 but a major disappointment occurred the following year, one from which the company never fully recovered. As it was well known that the Air Service planned to procure another two hundred of the improved MB-3A design, Thomas-Morse invested in the necessary jigs and dies. However, the policy at the time was to offer the contract out to bid and Boeing offered the lowest price and obtained the order. Interestingly, Reuben Fleet was in charge of purchasing and had attempted to get Thomas-Morse to lower its price below $13,200 per unit. In later years, Fleet himself was the victim of this policy when he lost a Consolidated contract to Martin.

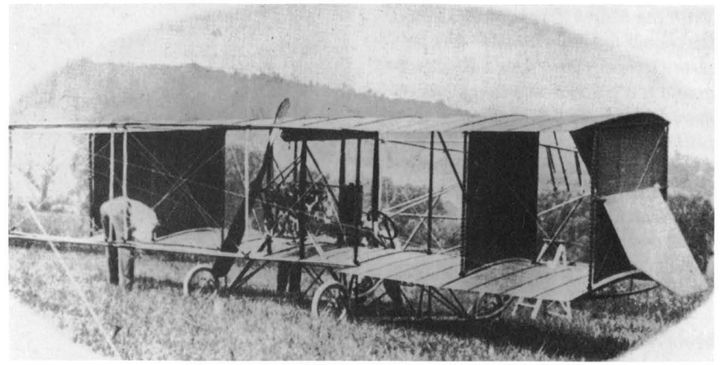
Following the loss of the MB-3A contract, the company concentrated on all-metal designs, the first US manufacturer to do so, starting with the MB-9 and MB-10 in 1921. But little success was achieved for the first seven years. As B Douglas Thomas recalled, 'we got the jump on everybody with the S-4 and then we got the jump on everybody with the MB-3. But when we tried to get the jump in metal, we were in real trouble.' The US lagged far behind Europe, particularly Germany, in metal aircraft design and construction and Thomas-Morse frequently had to adapt woodworking tools for the task. Corrugated sheets were made by running smooth stock through a wood planer fitted with corrugated rollers and to make extrusions, dies were procured by the company and loaned to the Aluminum Company of America. Dural tubing

was available only in limited sizes and much material was purchased in England from Vickers.

Although the TM-22/24 series proved unsuccessful, they attracted considerable attention for Thomas-Morse. In late 1924 the Army ordered two sets of metal wings for the DH-4 which were static and flight tested, followed by another pair for the Boeing PW-9 which were similarly satisfactorily tested. In 1925, the Air Corps suggested that the company undertake a metal version of the Douglas O-2. Two XO-6s were produced at a loss of $60,000 followed by three production aircraft. A completely new design, the XO-6B, followed. In 1928, this redesigned model was procured as the XO-19 and, following tests that proved the soundness of the concept, it was expected that substantial orders would be placed.

Before this occurred the Morse Chain Company was sold to Borg-Warner. The aircraft subsidiary, considered a financial liability, was omitted from the transaction, however. Frank L Morse remained in charge and on 5 August, 1929, he sold the company's designs to Consolidated Aircraft for 6,000 shares of Consolidated stock (worth about $440,000 at the time). Fleet had become interested in the company at the invitation of F Trubee Davison, Assistant Secretary of War for Air, who was concerned that Thomas-Morse would be unable to produce the O-19 in quantity. Thomas-Morse was transferred to Buffalo as a subsidiary of Consolidated, becoming Unit 4 at the North Elmwood Avenue plant, and completed 171 O-19s, the last in 1932. The final aircraft to bear the Thomas-Morse name was the XO-932, the ultimate development of the O-19 series, later designated Consolidated Model 23.

B Douglas Thomas, responsible for all the company's designs except the S-7, moved to Buffalo as president and chief engineer. His last work there was on the Consolidated Model 24 (XB2Y-1) dive-bomber for which the Navy supplied the basic designs. But it was not a success, and he retired in July 1933 to live in La Jolla, California. Thomas-Morse ceased to be an active part of the Consolidated corporate structure and two years later was quietly dissolved. William T Thomas, the founder of the enterprise, had left in 1921. For many years he devoted his time to building and flying model aircraft and in 1928 joined the Cunningham-Hall Aircraft Corp as chief engineer.



The first Thomas design in its original configuration with large panels mounted outboard of the wing struts. (Aircraft Year Book)

Thomas and Thomas-Morse Production Summary

Thomas

Biplane	1
TA*	2
TA Tractor**	1
Monoplane	1
Nacelle Pusher	2
E*	12
B (Flying-boat)***	4
T-2	25
SH-4	15
D-2/D-5/HS	6
Sub-Total	69

Thomas-Morse

S-4	1
S-4B	101
S-4C (Gnôme)	50
S-4C (Le Rhône)	447
S-4C (post contract cancellation)	1
S-4E	1
S-5	6
S-6	1
S-7	1
S-9	1
MB-1	1
MB-2	1
MB-3	65
MB-4	2
MB-6	3
MB-7	2
MB-9	1
MB-10	1
TM-22 (R-5)	2
TM-23	1
TM-24	1
XO-6	2
O-6	3
XO-6B****	1
XO-19****	1
O-19	2
O-19A	1
O-19B*****	70
O-19C*****	71
O-19E*****	30
YO-20	1
XO-2	1
YO-23	1
XO-932/Y1O-41 (Consolidated 23)*****	1
XP-13 Viper	1
Sub-Total	876
TOTAL	945

In addition, a fuselage of the Y1O-42 was built for static tests only.

A contract to convert seventy-five DH-4s to DH-4B standard was placed but none were delivered.

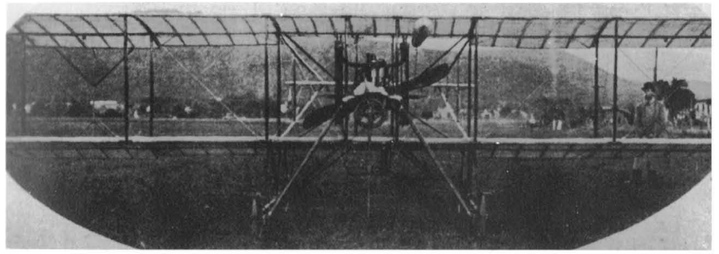
* Possibly interchangeable, at least one 'school machine' was built at Ithaca.

** Possibly converted from existing TA.

*** Possibly only three aircraft.

**** Possibly same airframe

***** Built by Consolidated at Buffalo.



The Model TA in its original form with a 50hp Kirkham engine with single pilot controls. (Aircraft Year Book)

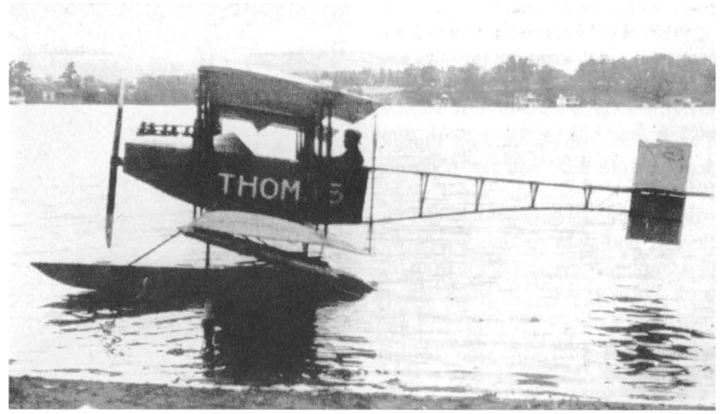
TA Tractor with 50hp Kirkham engine. (Aircraft Year Book)

Thomas Brothers Aircraft

Biplane

Thomas started work on his first aircraft at Hammondsport in November 1909 and the pusher biplane was first flown from Page Farm, Hornell, New York, the following spring by Bert Chambers. The machine seated pilot and passenger side-by-side on the leading edge of the lower wing. In its first form, large panels pivoting on fore and aft hinges at the centre of the outboard wing struts served for roll control. Later, these were replaced with ailerons. The four-wheel undercarriage was mounted on bamboo skids attached to the wing centre section that supported the 22hp Kirkham automobile engine with its chain-driven propeller. With two on board it could stay aloft for 20 minutes. Subsequently the elevator, supported by bamboo struts, was modified and twin rudders fitted and the chain-drive was abandoned in favour of a direct-drive system.

Span 27ft; weight empty 650lb.



TA

The second Thomas design was a refinement of the first and initially flew at Bath with a 50hp Kirkham six-cylinder aero-engine that permitted up to three persons, including the pilot, to be carried. During 1911, it was converted into a successful hydroplane by substituting pontoons for the wheels, and was still able to carry one passenger.

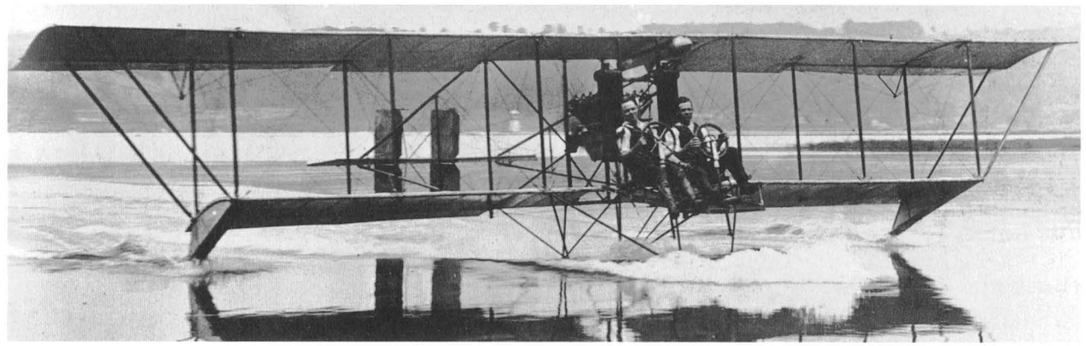
In 1912, a further improved model TA was built with a 65hp Kirkham engine and on 31 October, was flown by Walter E Johnson at Bath with a passenger for 3hr 51min, an American endurance record. The improved TA also won a series of races including the 25-mile $1,000 prize event at the Syracuse State Fair in 1912

TA Tractor

In 1912, an unsuccessful tractor version of the TA biplane was built (or converted from an existing TA) with a 50/65hp Kirkham engine, fitted with a single pontoon and outrigger floats for water-based operations. Performance was not as good as the original TA and further work was abandoned in favour of pusher designs.

Span 37ft; weight empty 900lb; maximum speed 58mph; endurance 2hr.

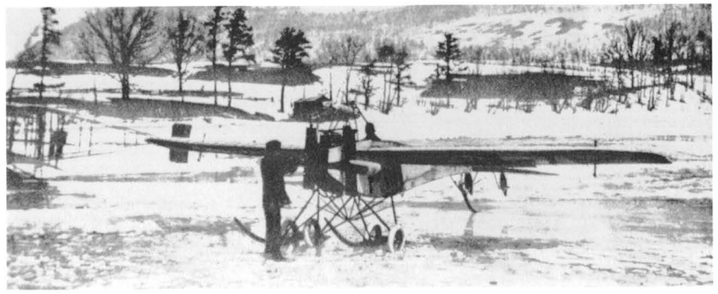
A Model TA converted as a hydroplane. This may be the improved version with a 65hp Kirkham as it has dual controls (Harold Andrews collection)



Monoplane

A single-seat monoplane with a 50/60hp Maximotor four-cylinder engine was built in 1913 and was flown during the spring. The paired four-wheel undercarriage was supplemented by skids. The intention was to install a 70hp Kirkham engine but it is unlikely that this was done.

Span 32ft, length 30ft; weight empty 750lb.

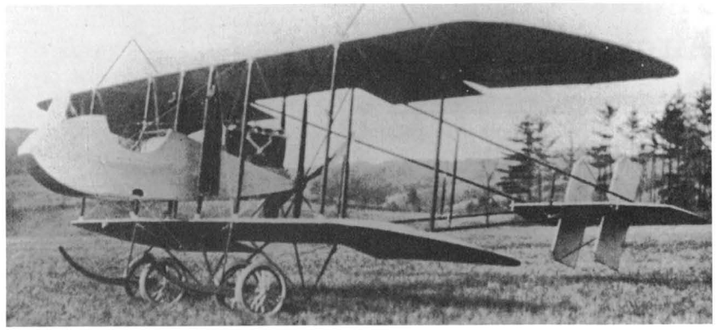


Thomas Monoplane (50hp Maximotor). (Aircraft Year Book)

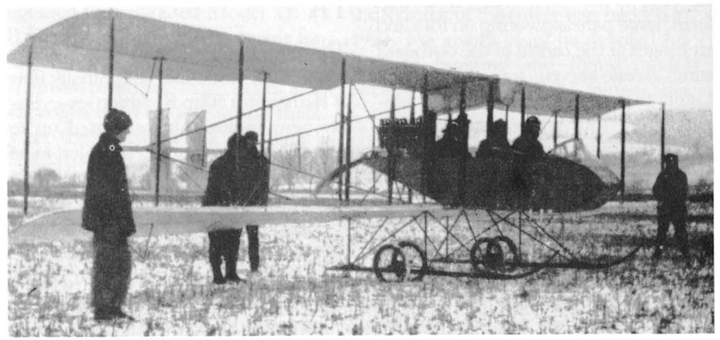
Nacelle Pusher

Two similar 'nacelle pusher' biplane designs were built and flown during 1913. Both featured paired four-wheel/skid undercarriages and had the elevator and twin rudders supported by a bamboo frame extending from the wing centre section. The single-seater, also referred to as the Standard Biplane, had a 10ft longer-span upper wing, a 65hp Kirkham engine, and a nacelle mounted in between the wings. The three-seater, powered by a 90hp Austro-Daimler engine, had the longer nacelle attached directly to the lower wing.

(Single-seater): Span 37ft; weight empty 900lb; maximum speed 58mph, endurance 2hr.

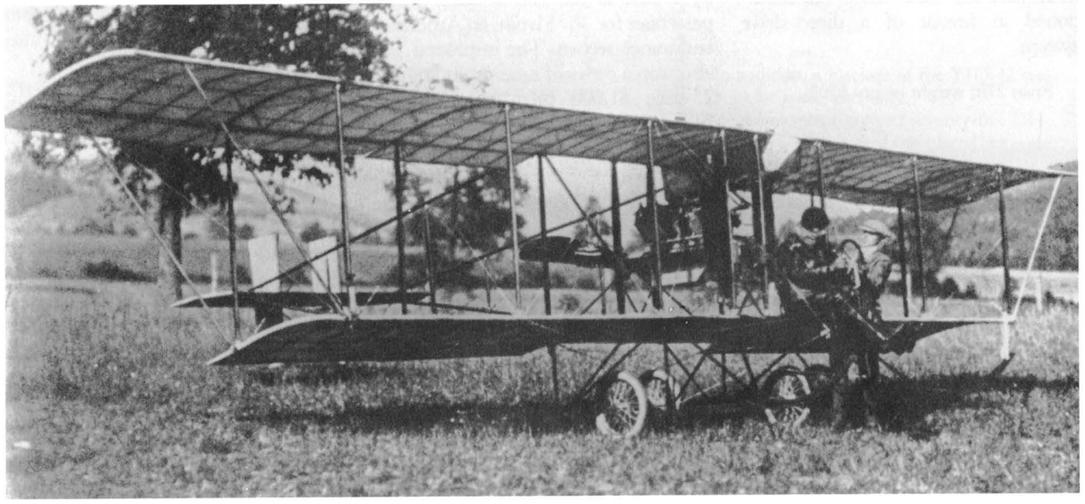


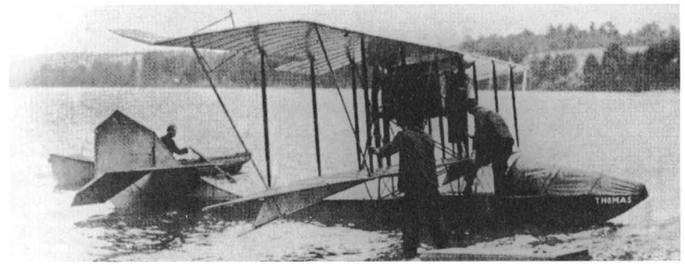
Single-seat Nacelle Pusher (1913). (Aircraft Year Book)



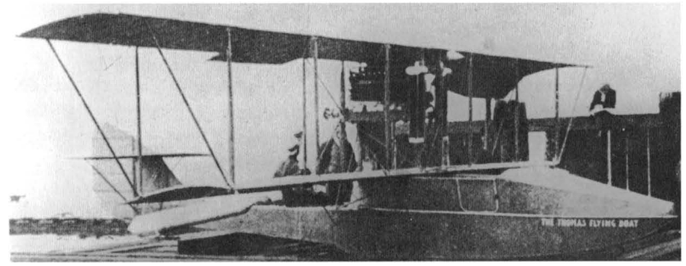
Three-seat Nacelle Pusher (1913) with 90hp Austro-Daimler engine. (Aircraft Year Book)

Model E single-seater. (Aircraft Year Book)

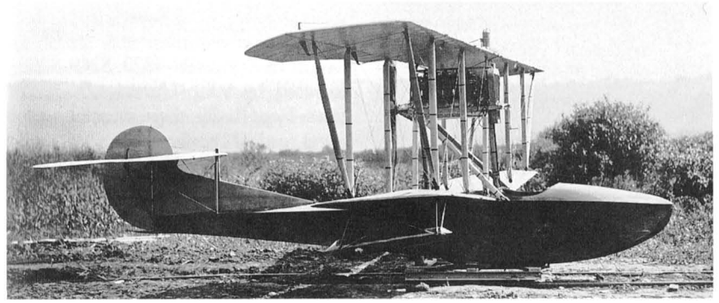




Original Flying-Boat, on Lake Salubria in 1912. (Aircraft Year Book)



Second Flying-Boat, with a steel-covered hull and a 90hp Austro-Daimler engine. (Aircraft Year Book)



1915-model Flying-Boat (B-4) with streamlined bow and extended fin. (Harold Andrews collection)

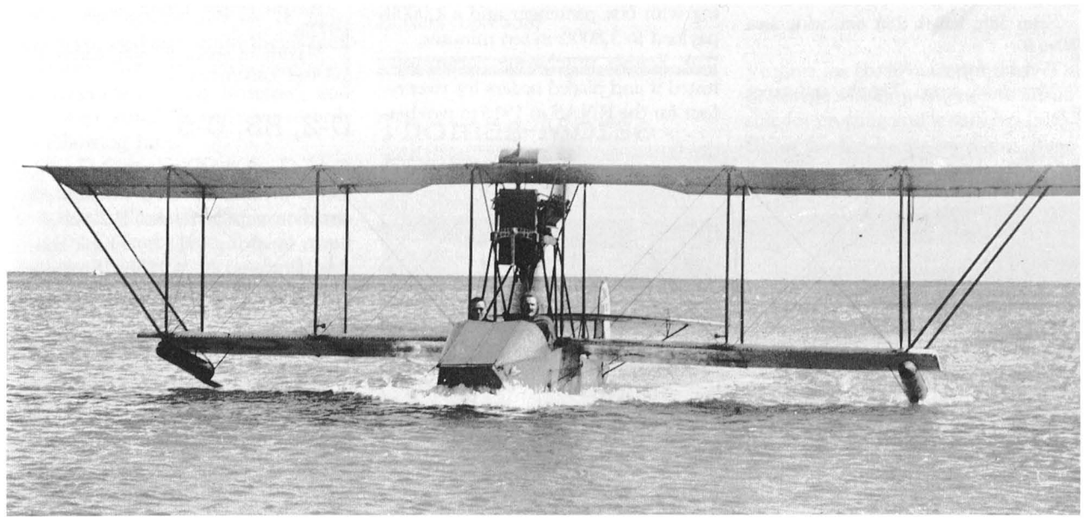
Model E

Developed from the TA, twelve aircraft were reportedly built from 1913 with 65hp Kirkham engines. The specifications were similar to those of the TA but at least one, known as the Special Biplane, had 33ft span wings and a gross weight of 850lb. Fitted with an 80hp Curtiss engine, one was flown by Frank H Burnside, an early graduate of the Thomas School of Flying and subsequently chief pilot of the company, to 13,000ft in 1913 to claim a new US altitude record. One aircraft survives with Cole Palen's collection at Old Rhinebeck, New York.

Model B Flying-boats

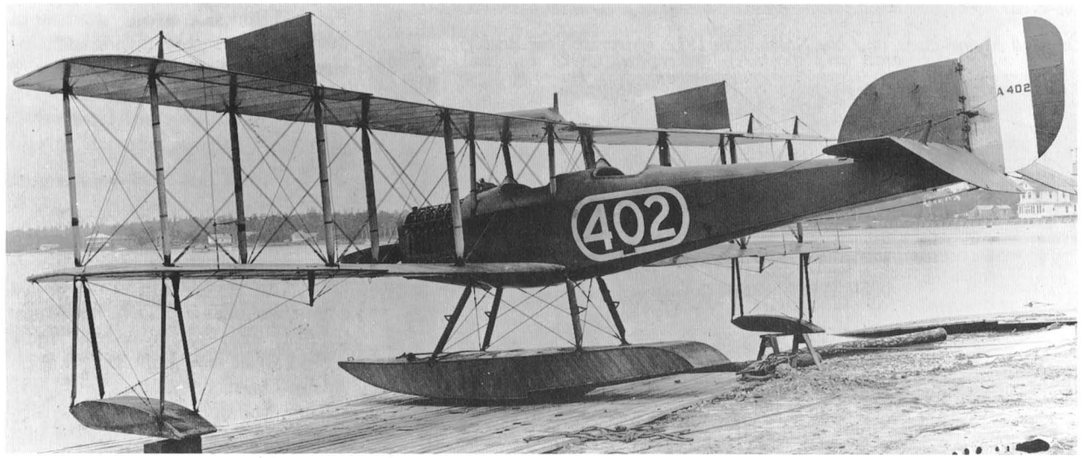
A side-by-side two-seat biplane flying-boat with a 60/65hp water-cooled engine was built and flown from Lake Salubria in 1912. A second, more refined 'boat, was built with a 90hp Austro-Daimler engine and was capable of 65mph. As the Thomas brothers had trouble with the wooden hull absorbing water, thus adding weight to the aircraft, 30-gauge galvanised iron sheets were used to cover the wooden frame hull of the second aircraft, reinforced at the bow and underneath with wood planking. In 1914, a third design appeared with the same engine and this, together with a more streamlined model produced in 1915, also with a 90hp Austro-Daimler, has been

The 1914 model Flying-Boat (B-3) on Lake Salubria. (Stephen J Hudek)



Prototype T-2 at Ithaca (90hp Austro-Daimler). (Harold Andrews collection)

SH-4 A-402 photographed on 18 June, 1918. (National Archives, Navy Dept)



referred to as the B-3. Possibly, one of the airframes was a conversion of an earlier aircraft. In any event, the final aircraft was built of mahogany and intended as a luxurious cruiser for two or three people.

1914 model

Span 36ft 4in; length 25ft 6in.
Weight empty 1,275lb.
Maximum speed 65mph.

1915 model (B-3 or B-4)

Span 38ft; length 28ft 6in; wing area 360sq ft.
Weight empty 1,250lb.
Maximum speed 70mph; endurance 4hr.

T-2

The first design by B Douglas Thomas for Thomas Brothers was based on the Model J he had designed for Curtiss. Work started at Bath then moved to Ithaca, New York, on 7 December, 1914, and the first flight was made soon after arrival there. Powered by a 90hp Austro-Daimler, the T-2 had two-bay wings and was rated as the best performing aircraft of its day achieving a maximum speed of 83mph and climbing with one passenger and a 1,000lb payload to 3,800ft in ten minutes.

A British purchasing commission tested it and placed orders for twenty-four for the RNAS in 1915 in two batches of twelve (3809-3820, 8269-8280) powered by 90hp Curtiss OX-5 engines. Reportedly, there were no additional orders because of a growing shortage of the Curtiss OX.

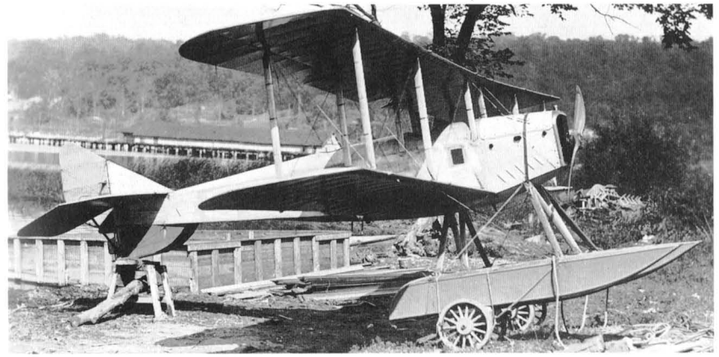
A single main float development with a three-bay wing and enlarged fin and rudder was the SH-4 of which fifteen were ordered by the Navy (A-134/136, 395/406) in 1916.

Span 36ft; length 26ft; wing area 350sq ft.
Weight empty 1,075lb; gross weight 1,972lb.
Maximum speed 83mph; climb with full load 3,800ft/10 min.

Frank Burnside poses with the D-2. (Harold Andrews collection)

D-2, HS, D-5

A two-seat, two-bay equal-span biplane of fabric-covered wooden construction similar to the T-2 was first flown in spring 1915 by Frank Burnside. Powered by a 135hp Sturtivant engine, the D-2 achieved an unofficial world record of 97.4mph and a rate of climb of 4,500ft in ten minutes. Two D-2s with twin main floats and a pontoon skid fitted directly underneath the rear fuselage were ordered by the Navy in July 1915 with the designation HS (AH-20/21, later A-57/58). A prototype HS was first flown from Renwick



Prototype HS (135 hp Sturtivant) at Renwick Park (now Stewart Park), Ithaca, in summer 1915. The small window in the fuselage forward of and below the cockpit assisted judgement in landing. (Harold Andrews collection)

One of two D-5s built for the US Army in 1915 (135hp Thomas 8). (Harold Andrews collection)

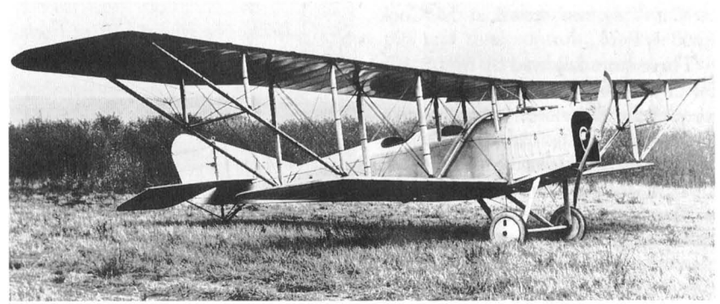
Park, Cayuga Lake, in late summer 1915 but the extra drag of the floats demanded higher power settings for which the radiator was inadequate. A heavy alighting was suffered early in the flight-test programme, following radiator problems, which necessitated repairs and subsequently the aircraft was destroyed, without fatal injuries to the pilot, when it crashed into the lake in early winter.

The two Navy aircraft were modified after the crash of the first HS to incorporate side mounted radiators for improved engine cooling, an upper wing with 11ft 6in increased span and larger ailerons, instead of upper and lower sets previously. The rear pontoon underneath the tail was lowered by mounting it on struts that lifted the rear fuselage out of the water. The first (AH-20) was shipped to Pensacola, Florida, with a 135hp Sturtevant engine in late February 1916, and accepted after flight tests on 30 March. The second, with a 135hp Thomas 8 engine, almost a duplicate of the Sturtivant, was handed over on 18 June. Both were used for training flights until November, when they were reassigned for experiments with 'wireless', and both were struck from Navy records the following June.

The D-5 was similar to the D-2 but had unequal span wings, the upper wing with a considerable over-hang. Two D-5 observation models were built for the Army for evaluation in 1915 (114/115) with 135hp Thomas engines.

HS (revised version)

Span 48ft 6in; length 29ft 9in; height 10ft 3in; wing area 441sq ft.
Weight empty 2,600lb.
Maximum speed 82mph.



The prototype S-4 with 100hp Gnome had a 29ft 5in long fuselage. (Peter M Bowers collection)

Thomas-Morse Aircraft

S-4 Series

In late 1916, B Douglas Thomas designed a conventional biplane scout trainer around the 100hp General Vehicle Company-built nine-cylinder Gnome rotary engine. The prototype was tested in spring 1917 at Ithaca by Frank Burnside. In June 1917, it was evaluated by the Army at Hampton, Virginia, as an advanced trainer. The prototype's Gnome engine was unsuitable for cruising and it suffered from a 5lb or 6lb tail-heavy condition, therefore it was only used for short exhibition and training flights, accumulating a total of 250 hours by the time it was scrapped.

At the request of the Engineering Division, a number of changes were made to the design including shortening of the fuselage by 2ft 9in, replacement of the Deperdussin-type control wheel with a stick, reduction in area of the ailerons, elevators and rudder, and trailing edges changed from wood to steel. In this form, one hundred S-4Bs (4276/4375) were ordered on 3 October

and a second prototype incorporating all the specified revisions was flown in November. This, however, crashed on landing at Cornell University on 21 December, 1917, when being flown by Tex Marshall, and was destroyed.

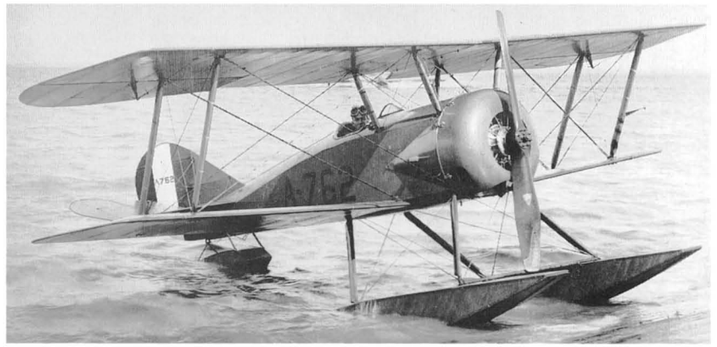
The wings of the S-4B were said to have the largest stagger of any aircraft built up until then, but structural tests with sandbags weighing over seven times the aircraft weight proved that there was no weakness. The fuselage was built of spruce and ash members with fabric covering except for an aluminium firewall and cowling. One S-4B (4355) was tested at McCook Field as P-26.

These were followed by fifty S-4Cs (41359/41408) with push rods and torque tubes for aileron control, similar to the Nieuport, an example of which had been sent to Ithaca, and provision for one Marlin 0.30in gun.

The Gnome had proved troublesome, using 3 gallons of castor oil an hour and depositing a fine spray of it over the starboard wing and cockpit. The high-pressure fuel system when fractured in an accident would also spray fuel over the hot engine. Therefore, a further 447 S-4Cs (36509, 38633/38982, 44578/44674) were delivered with a 90hp Le Rhône C-9, which only consumed one gallon of oil an hour, built by the Union Switch and Signal Co, Swissvale, Pennsylvania. Another 500 were cancelled, after over half the parts had been already made, and one more S-4C was completed by the company as a demonstrator, making a total of 601 S-4/B/Cs built. Large quantities were used at Carlstrom Field, Arcadia, Florida; Gerstner Field, Lake Charles, Louisiana; and Rockwell Field, San Diego, California. The Navy also used ten S-4Bs (BuA 3235/3244) and four S-4Cs (BuA 5855/5858) diverted from Army stocks. Noted for its relatively high speed, climbing ability and reasonably fine handling in the air, the 'Tommy Scout' retained the tail-heavy condition of the prototype and was prone to ground looping.

Following tests at Cayuga Lake with the prototype S-4 fitted with twin floats, six S-5s (BuA-757/762) were built in 1918 for the Navy. These were basically S-4Bs with triple floats copied from the Sopwith Baby and were used

S-4C 38635 (Le Rhône C-9) at Rockwell Field, San Diego, in late 1918. (Harold Andrews collection)



S-5 A-762 was one of six used by the US Navy at Dinner Key, Miami. (Peter M Bowers collection)

The S-4E was designed for aerobatic training, with a 110hp Le Rhône and tapered wings. (A R Krieger collection)

The S-4E was later raced by Basil Rowe with a 135hp Aeromarine 737 engine with the name Space-Eater. (Harold Andrews collection)

With two seats and dual controls, the S-6 was intended for the civil market but only one was built. (Harold Andrews collection)

Also a two-seater, the S-7 had a single cockpit and side-by-side seating and was advertised as the Sociable Seater. (Harold Andrews collection)

This OX-5 conversion of an S-4 has the second seat behind the pilot. (Peter M Bowers collection)

at NAS Dinner Key, Miami. At least one (A-758) flew with a revised rudder which was taller, but of reduced span.

During summer 1918 and the immediate postwar period, several designs based on the S-4 basic concept were completed. The S-4E was an aerobatic trainer with a 110hp Le Rhône, tapered wings and redesigned tail surfaces similar to the SPAD, and a new undercarriage. The top wing had a span of 22ft and the lower 14ft. Possessing a marked tail-heaviness and inadequate propeller ground clearance, it was sold engineless to Basil Rowe.

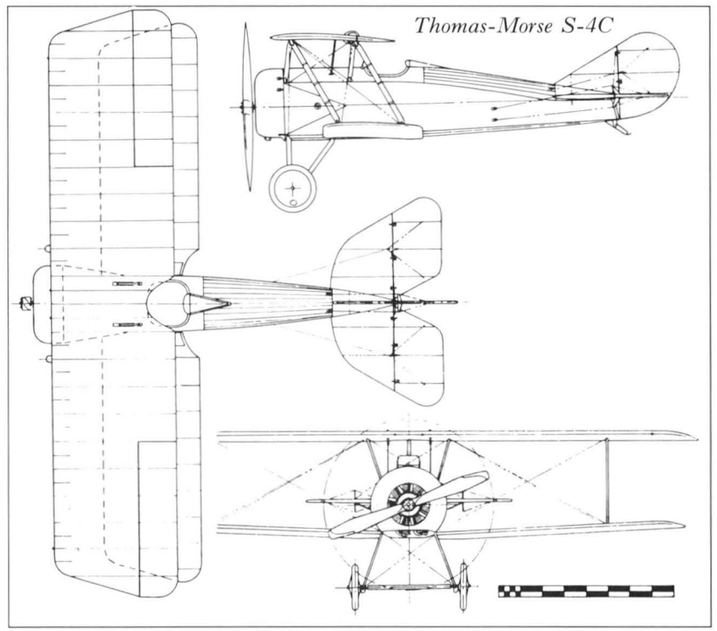
The S-6, with two single-seat cockpits and dual controls, fuselage lengthened by 10in and a wing span of 29ft, was intended as a civil sport/training type and was powered by an 80hp Le Rhône. Entered in the 1919 National Air Races at Kansas City, it came second and it was flown by Paul D Wilson from Ithaca to Washington on 30 April, 1920, and on to McCook Field on 10 May to demonstrate its cross-country ability. Top speed was 105mph and its ceiling was almost 20,000ft. Later registered C98, the S-6 was used by the Ithaca Flying Service, then sold to Fred Krehnlein of Rochester, New York, in 1931, and crashed after a low-altitude spin.

The similarly-powered, 32ft-span S-7 accommodated the pilot and passenger in a single wide cockpit and was advertised as the Sociable Seater. The S-7 was designed by W T Thomas, Agnew Larsen, and Raymond Dowd, and completed in 29 days after work started. First flown by Tex Marshall, it was eventually sold to Basil Rowe and Clarence Chamberlain and used for aerial mapping.

Using the wings from the S-6 and standard S-4C tail surfaces, but with a side-by-side two-seat cockpit and powered by a 200hp Lawrance J-1, the S-9 trainer of 1923 featured a wrap-around corrugated sheet metal fuselage in a conventional configuration to respond to current Army interests. The company-owned prototype was tested at McCook Field as P-313 and later at Kelly Field, Texas, and finally written off in a crash following failure of a wing strut attachment fitting.

The S-4 series was popular on the secondhand market and over sixty were registered to private owners until grounded by the increased stringency

The Yackey Sport, a two-seat conversion of the S-4, had an OX-5 water-cooled engine. (Peter M Bowers collection)



of regulations in the late 1920s. Some were re-engined with the Super-Rhône ZR-1 and ZR-2, radials converted from rotaries by Tips and Smith Inc, Houston, Texas. Many S-4s were converted with 90hp Curtiss OX-5 water-cooled engines, some with a second seat behind the pilot. Another side-by-side two-seat version using the OX-5 was manufactured by the Yackey Aircraft Company, Maywood Field, Illinois, as the Yackey Sport. Several were produced as Dycer Sports by Charles Dycer at Dycer Field, Los Angeles, in 1926-27. Private owners made innumerable modifications and some S-4s were converted into parasol monoplane configuration. One such conversion was fitted with an arcurate control system, designed by R C Stroop, in Alabama in 1932. The upper wing panels of S-4Cs were used on the initial examples of the popular Heath Parasol built in 1927 and several S-4Cs were used by Hollywood for film making. One was leased to Northwest Airways for one month in October 1926 to start mail services.

Popular on the civil market after the First World War, there were a number of conversions made to the S-4.One of the more radical was made by Lawrence W Brown at Clover Field, Santa Monica, California, who turned an S-4 into a two-seat monoplane with a Curtiss OX-5 engine and a radiator from a Curtiss JN-4. (Peter M Bowers collection)

Also favoured for air racing, one S-4C flown by H F Cole came second in the On to St Louis race at the 1923 National Air Races. Another, registered G-CAEH, was entered at Dayton in 1924 and an S-4C modified with a Curtiss OX-5 came second in the On to Dayton race, flown by Charles Holman. For the following year's races, Basil L Rowe modified the S-4E with a 135hp Aeromarine 737 liquid-cooled V-8 engine. Named *Space-Eater*, it won first place in the Free-for-All race at Mitchel Field, New York, averaging 102.9mph. Second in the event was a S-4B (Curtiss OX-5) flown by E P 'Bert' Lott. Rowe won the B B T Trophy race at Philadelphia with *Space-Eater* in 1927.

A number of S-4s are extant in museums in the United States and two are still regularly flying in the Spokane, Washington, area, and at Old Rhinebeck, New York.

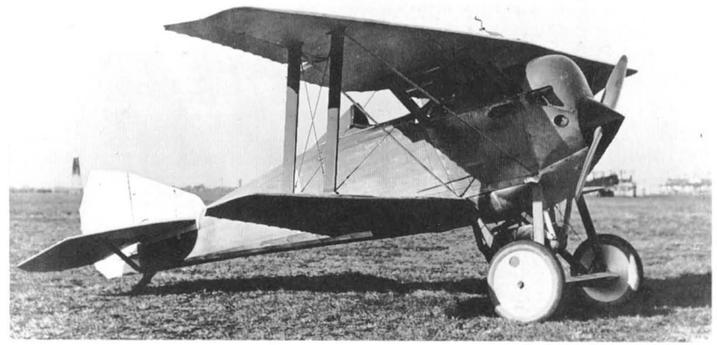
S-4C

Span 26ft 8in; length 19ft 10in; height 8ft 1in; wing area 234sq ft.

Weight empty 963lb; gross weight 1,373lb.

Maximum speed 95mph; climb 7,500ft/10min; service ceiling 15,000ft.

The S-4E Space Eater, *fitted with an Aeromarine B engine and cylindrical Lamblin radiator between the undercarriage struts.* (Peter M Bowers collection)



Constructed in such a fashion as to save as much weight as possible, the MB-1 proved structurally inadequate and was only flown twice. (A R Krieger collection)

The performance of the MB-2 (25806) was poor even with a four-blade propeller. (Wright Field)

MB-1

After concentrating on trainers, attention was turned to an experimental two-seat, high-wing parasol monoplane (Mono-Biplane) fighter, powered by a 400hp Liberty 12. Faired struts offered additional lifting area and in an effort to make the airframe as light as possible, all metal parts were given holes and the plywood bulkheads had cut-out sections. Even the control column was perforated.

Two aircraft were ordered (including one for static tests only) in 1918 and built at the Center Street building. But by the time the prototype had reached the flying field, towed behind a truck, the undercarriage had already been weakened and repairs had to be made. When the aircraft sat in the hangar, the tailskid fittings failed and the skid was pushed through the tail. Taxi-ing and flight tests were begun on the ice of Cayuga Lake but the undercarriage failed on take-off on its first flight. The MB-1 was repaired and flown only once more, then abandoned.

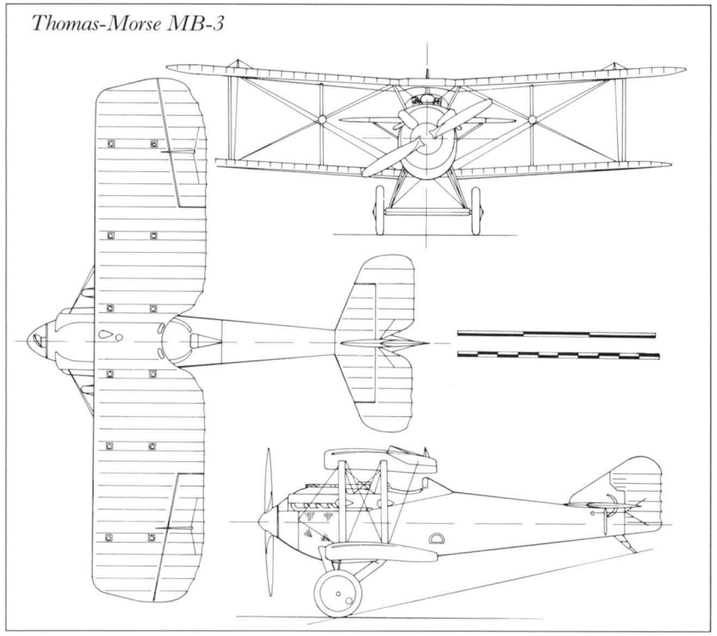
Span 37ft; length 22ft.

MB-2

The second attempt at a pursuit fighter, the MB-2 was a two-seat, two-bay equal-span biplane with a 400hp Liberty 12-C with spur-gear reduction mechanism and a two-bladed propeller. The top wing had conventional front and rear spars but the lower wing had an additional centre spar and radiators each side of the fuselage. The single prototype (25806) was later fitted with a 450hp Liberty, a four-bladed airscrew, and a new radiator system, but performance was still poor and it was scrapped in 1918 along with the half-completed fuselage of a second aircraft.

Span 32ft; length 24ft.

Thomas-Morse MB-3



MB-3 Series

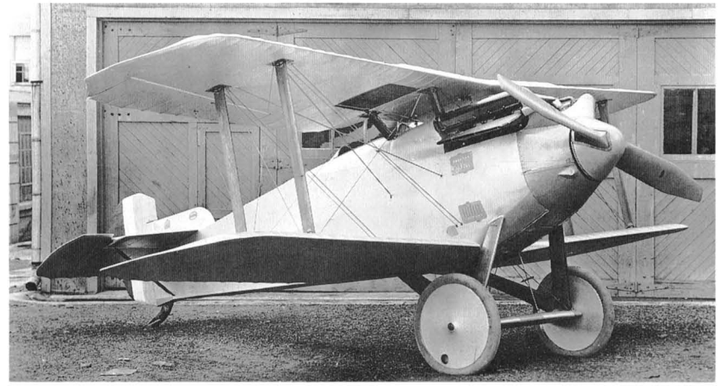
In 1918, Thomas-Morse was invited to design a new single-seat fighter, superior to the latest SPAD models, around the 300hp Wright H licence-built Hispano-Suiza water-cooled V-8 engine. The all-wooden design was entirely conventional with a one-piece upper wing and two separate lower sections of RAF 15 aerofoil with solid spruce spars and three degrees of dihedral. Ailerons were fitted to the upper wing only which accommodated a radiator and a 3-gallon gravity fuel tank and featured a large cut-away section to enable the pilot access to a very cramped cockpit. Space was so limited that there was no room for a panel for instruments and these were scattered around wherever space could be found. Two other fuel tanks were placed in the fuselage, one of 18US gal capacity forward of the pilot and one 20US gal under the rudder bar. Two 0.30in Marlin machine-guns were mounted beneath a turtle-deck cowling.

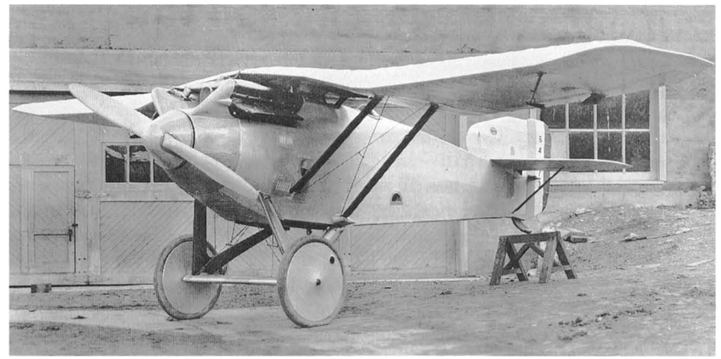
Four prototypes (40092/40095) were ordered in September 1918 and the first of these flew at Ithaca on 21 February, 1919, achieving a speed of 168mph and climbing to 10,000ft in 4min 52sec – claimed as an unofficial world record for Service-type aircraft. Shipped to the Air Service's Engineering Division at McCook Field, Dayton, Ohio, for static testing, 40092 did not fly again. The other three prototypes were assigned 'P-numbers' by the Flight Test Section, P-66 (40093, cannibalised for parts after 1921), P-124 (40094, damaged in transit and returned to factory for repairs, crashed 30 March, 1921), and P-121 (40095, survived until October 1926).

Although the McCook pilots found the MB-3 easy to taxi and the flight characteristics generally favourable, they reported that the pilot's view in the air was poor and the cockpit was far too small. Maintenance was a severe

The second production MB-3 at McCook Field, marked P-164. (McCook Field)

Three clipped-wing MB-6s (400hp Wright H-2) were produced for the US Army for the 1921 National Air Races. (Harold Andrews collection)





problem, especially concerning fuel leaks from the complicated shape of the main tank and oil would become trapped in the bottom of the fuselage causing the supports to rot and allow the tank to break through after only ten hours of flight. The radiator gave trouble, as did the untried and complicated fuel system which necessitated the cutting of holes into the fuselage structure to gain access to the magnetos. Also, the airframe suffered badly from engine vibration. In response to these criticisms, several modifications were made to 40095. The cockpit was lengthened (but not widened), the radiator was moved slightly to the right of the centreline to allow for a larger 12US gal gravity fuel tank, and structural strengthening increased the empty weight by 130lb.

In this revised form, together with a cut-down vertical fin, the Army ordered 50 production MB-3s (63331/63380) from Thomas Morse on 19 June, 1920, which were delivered from November. Four production aircraft were tested at McCook (P-164/63332, P-197/63336, P-201/63338, and P-208/63337) to develop further improvements including more structural reinforcement and a revised cooling system with radiators each side of the cockpit instead of one on the upper wing.

A contract for two hundred MB-3As (68237/68436) with the above revisions plus an armament of one 0.30in and one 0.50in Browning machine-gun was given to Boeing in April 1921 which had underbid Thomas-Morse (and four other manufacturers) under the competitive bidding system then prevailing. Worth nearly one and a half million dollars, it was the largest contract for pursuit fighters awarded until 1937. One pattern aircraft (63332) was sent to Boeing but crashed on landing at Seattle. The first Boeing-built MB-3A was flown at Camp Lewis on 7 June, 1922, and on landing, ran through a small ditch and overturned. All aircraft were delivered between 29 July and 27 December, 1922. Two and four-bladed propellers, the latter an attempt to reduce vibration, were used interchangeably on the MB-3A and the final fifty aircraft had redesigned tail surfaces with the fin area more than doubled (a feature tested on 68237/P-259 at McCook).

The first Navy MB-7 racer, with an Alula wing, crashed during the 1921 races at Detroit. (Harold Andrews collection)

After replacement in front-line service by Boeing MB-3As, some MB-3s became MB-3M advanced trainers at Kelly Field, Texas, with the 43rd School Squadron and were finally withdrawn from use in 1929. The MB-3B was a Boeing-proposed model with a 2ft stretched fuselage and four ailerons but was not accepted.

The MB-3 and MB-3A were both used for air racing, starting in 1920 when Capt Harold E Hartney was placed second in the Pulitzer Trophy Race in a prototype MB-3 (number 41). Another prototype MB-3 (number 43) was entered by Lt Leigh Wade but had to retire after the first lap. Army use of the MB-3 in the races _continued until 1923.

For the following year's races, Thomas-Morse received a contract for three MB-6s on 24 May, 1921 (68537/68539). These were clipped wing (19ft span) versions of the MB-3 with a 6in shorter fuselage, gross weight reduced to 2,023lb, and a 400hp Wright H-2. The three were shipped unflown from Ithaca to McCook Field and after one was used for static testing (68539/P-370), another (68537) was first flown on 21 October by Lt John A Macready. However, this was destroyed in a landing accident four days later when flown by Capt C C Moseley (winner of the 1920 race). Therefore, the surviving MB-6 (redesignated R-2 in the Army Racer series) was shipped directly to Omaha, and with Macready came second with a speed of 160.7mph.

A second Army contract had been placed on 16 May, 1921, for twelve MB-3s for delivery to the Marines. This was later changed at the Navy's request to ten MB-3s (BuA-6060/6069) and two MB-7 monoplane racers (BuA-6070/6071 ex-64373/64374). The MB-7 featured a modified 24ft span strut-braced parasol 'Alula' wing and a 400hp Wright H-2. First flown on 24 October at Ithaca by Hartney, the first MB-7 (64373) crashed after fuel pump

The MB-4's unusual arrangement of two nacelles for payload and the engine in the centre section resulted in very poor flying characteristics.
(A R Krieger collection)

failure during the races. Completed in February 1922, the second MB-7 had a Wright H-3 engine and was first flown on 14 April by Marine Lt Francis P Mulcahy. However, it failed to finish in the 1922 Detroit event because of an overheated engine. After the race, the MB-7 was stored at the Naval Aircraft Factory, Philadelphia, until scrapped in May 1925.

An eleventh MB-3 was built to replace the crashed MB-7 and assigned the unused serial A-6070. All the MB-3s were delivered to MCAS Quantico during February 1922 for use by the Third Marine Air Squadron. After limited use they were stored, then delivered to the Army at Langley Field in 1923.

In 1927, several MB-3Ms and MB-3As were used in the filming of *Wings* to portray SPADs and German aircraft. Filming was mostly done at McCook and several were destroyed in crash scenes.

MB-3

One 300hp Wright H (Hispano-Suiza) eight-cylinder water-cooled engine.

Armament: Two 0.30in Marlin machine-guns.

Span 26ft 0in (upper), 24ft 6in (lower); length 19ft 11in; height 8ft 6in; wing area 250.5sq ft.

Weight empty 1,506lb; gross weight 2,094lb.

Maximum speed 152mph at sea level; cruising speed 144mph; climb 1,930ft/min; 6,500ft/3.9min; service ceiling 23,700ft; range 288 miles (41US gal fuel capacity).

MB-4

In June 1919, the US Post Office Department requested bids for ten aircraft powered by two or three Liberty or Hispano-Suiza engines, capable of carrying 1,500lb of mail on one engine. The MB-4 featured two 300hp Wright-built Hispano-Suiza engines, one as a tractor and one as a pusher, mounted in a nacelle between two fuselages built up in the same manner as that of the MB-3 complete with two separate tail units. The nose cockpit of the port fuselage housed the pilot, that of the starboard fuselage a pilot/mechanic. The payload was accommodated between the two engines in the centre nacelle and in both fuselages, behind the crew.

There was no means of communication between cockpits, the fuel system was inadequate, the engines caused vibration and set up an unbalanced couple that overloaded the airframe, and one fuselage would lift before the other on take-off. General plant superintendent Jerome Fried described the MB-4 as the, 'worst thing on wings.'

A few trial flights were made beginning in February 1920, including a demonstration to the Post Office Department on 1 March. At least one of the two aircraft built was delivered and stored by the government for at least a year before being scrapped.

Two 300hp Hispano-Suiza eight-cylinder water-cooled engines.

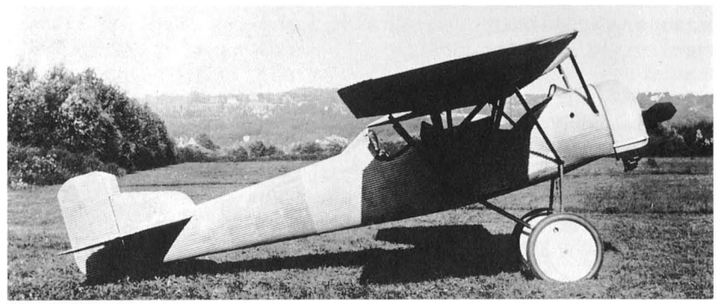
Accommodation: Pilot and mechanic in separate cockpits.

Span 45ft 6in; length 25ft $4^{3}/_{4}$ in; height 11ft; wing area 645sq ft.

Empty weight: 3,554lb; gross weight 5,564lb.

Maximum speed 122mph; single-engine speed 100mph; climb 9,000ft/10min; range 600 miles.

The 110hp Le Rhône-powered MB-10 had extremely poor flying characteristics.
(Harold Andrews collection)



MB-9, MB-10 and TM-22 (R-5)

Initiating all-metal construction, B Douglas Thomas designed two parasol monoplanes in 1921. Both featured wings built-up from duralumin channel members, covered with corrugated sheet, and fuselages fashioned from corrugated sheet laid over former rings which had to be opened up or drilled to permit riveting.

The first built was the MB-10, intended as a primary trainer with tandem cockpits and a 200hp Wright or Lawrance air-cooled engine. However, a 110hp Le Rhône rotary was fitted to the sole prototype which had extremely poor flying characteristics.

By removing the front cockpit and installing a 300hp Wright H-3, the MB-10 was transformed into the MB-9 single-seat fighter. The radiator and oil tank were in a tubular structure below the fuselage. Although its handling in the air was better than the MB-10, the problems of ineffective radiators, weak undercarriages, and cramped cockpits continued to plague the Thomas-Morse designs and, in the case of the MB-9, vibration from the engine caused structural problems.

After brief flight tests undertaken by Paul D Wilson, both designs were put into storage.

Because of the poor showing of US types at the Pulitzer Races of 1920 and 1921, four companies including Thomas-Morse were requested to design new pursuit-types in early 1922 capable of 190mph for that year's races at Detroit. Thomas-Morse chose the new 600hp Packard 1A-2025 twelve-cylinder engine for its TM-22, derived from the earlier two prototypes.

Two (68561/68562) were built and designated R-5 with different wing spans and featured, like the MB-9, an underslung radiator and oil tank. The first R-5 made its initial flight on 29 September, 1922, at Selfridge Field, with Capt Frank O'Driscoll 'Monk' Hunter, and developed cooling troubles immediately. New radiators (as fitted to the second R-5) were installed. The first R-5 (racing number 47) came eleventh (149.3 mph) and the second (number 48), flown by Lt Clayton L Bissell, placed tenth (155.5mph) in the races. A disappointing performance in comparison to the winning Curtiss R-6 that achieved 205mph on only 400hp.

The TM-22 (R-5) had the underslung radiator and oil tank used on the MB-9. The second aircraft (68562) was tested at McCook Field in 1923 as P-268. (Harold Andrews collection)

Both R-5's were returned to McCook Field and 68562 was tested as P-268 between January and June 1923. Both were subsequently statically tested to destruction.

R-5

One 600hp Packard 1A-2025 twelve-cylinder water-cooled engine.

Span 29ft 0in (68561); 25ft 0in (68562); length 19ft 9in; wing area 174sq ft (68561); 150sq ft (68562).

Maximum speed 174mph.

TM-23

In 1923, Thomas-Morse designed an all-metal 'alert pursuit' single-seat equal-span biplane around a 440hp Curtiss D-12 water-cooled engine. Although a single strut connected the wings, they were of cantilever design and the strut was planned to be eliminated eventually. The fuselage was extremely narrow and the cockpit so small that there was hardly space for a parachute and the rudder pedal stirrups were placed on either side of the engine. The undercarriage was of unusual design in that it only allowed three inches of travel.

During initial taxi-ing tests the rudder was found ineffective and the area was increased before the first flight—which was made unexpectedly by Paul Wilson when the aircraft bounced over a ridge and could not be brought to a standstill before the end of the field. Only one circuit was made because of the lack of control response and on landing the aircraft nosed over and damaged the propeller and upper wing. After the top wing was moved forward one foot, the aircraft was test flown without difficulty although the general handling was poor and stick forces abnormal in many attitudes. The 160mph top speed was 45mph below that expected and the aircraft did not exceed 175mph even in a slight dive. In addition, there were engine cooling problems and despite it being obvious the design had no future, testing continued for several months.

After complete redesign and rebuil-

The sole TM-23 pursuit fighter at McCook Field in March 1926.
(Harold Andrews collection)

Tested at McCook Field in February 1925, the TM-24 was unusual as the upper wing was 5ft shorter than the lower. (Harold Andrews collection)

ding, only the engine housing and fuselage (lengthened by 20in forward of the cockpit) was retained. Conventional braced wings were substituted and the span increased. This raised maximum speed to 190mph and made handling slightly better but it was still very uncomfortable for the pilot. After initial tests at Ithaca, it was shipped to McCook Field where the oil radiator failed on the first flight, in March 1926. After another four flights, the aircraft was dismantled, returned to Ithaca, and stored.

One 440hp Curtiss D-12 twelve-cylinder water-cooled engine.

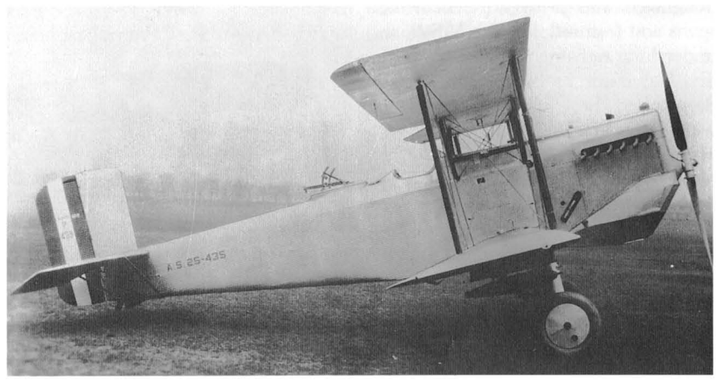
Span 19ft 6in (later 23ft); length 16ft 7 3/4in (later 17ft 6in).

Weight empty 1,918.5lb; gross weight 2,706.5lb.

Maximum speed 167mph at sea level; cruising speed 125mph; climb 10,000ft/7.3min; service ceiling 20,150ft; endurance 2.25hr (61US gal fuel capacity).

(Weights and performance in revised configuration)

The company-funded XO-6B (Wasp R-1340) at Ithaca. (Harold Andrews collection)



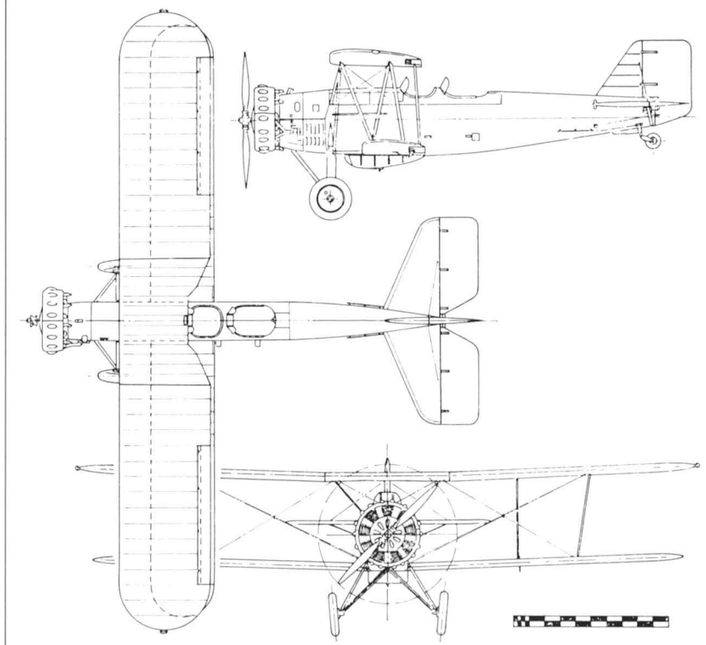
XO-6 25-435/P-439 at McCook Field in 1926. (McCook Field)

TM-24

The first design that could be termed successful in the series of Thomas-Morse experiments with all-metal construction was the TM-24, a two-seat observation biplane design of 1924 with a 440hp Curtiss D-12 engine. The two wings were of different size and shape, the upper having a 5ft smaller span and a 63in chord, the lower a chord of 51.5in and they were braced with a single large, faired N-strut and inverted V-strut on each side. In addition to the normal tailplane, there were auxiliary surfaces mounted at the top of the fin.

The company-owned prototype was flown extensively at Ithaca then delivered by air to McCook Field in February 1925. There it was given the number P-380 and received generally favourable test reports. But the air flow over the rudder was almost completely diverted when the gunner stood up in the rear cockpit. As lengthening the fuselage would have caused additional problems, the project was abandoned and the prototype was still in storage at McCook in 1925.

Thomas Morse O-19C



One 440hp Curtiss D-12 twelve-cylinder water-cooled engine.

Span 30ft 1in; length 20ft 5in; wing area 237sq ft.

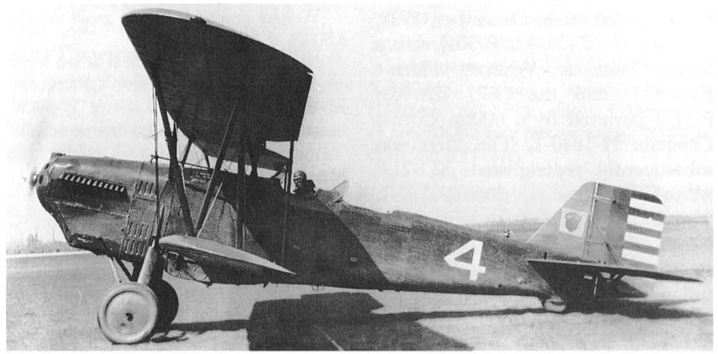
Weight empty 1,969lb; gross weight 3,470lb.

Maximum speed 143mph at sea level; cruising speed 114mph; climb 1,178ft/min; 5,000ft/5.1 min; endurance 2.75hr (84US gal fuel capacity).

O-6

On 21 April, 1926, the USAAC contracted Thomas-Morse to build two examples of a metal-structure version of the Douglas O-2. The first, designated XO-6 (25-435), had a 400hp Liberty 12 and wings of metal structure covered with duralumin on the upper and fabric on the lower surfaces. The XO-6 was tested at McCook Field in May 1926 (as P-439) and the second, designated O-6 (25-436/P-456), which had a 435hp Liberty V-1650-1 (12), was flown to Galveston, Texas, after testing at McCook, and left in an open hangar to test the effect of the salt-laden air on the duralumin skin.

Although the company reportedly suffered a loss of $60,000 on the contract, three more generally similar O-6s were built (25-437/439).



O-19B 30-90 was converted into the Y1O-33 with the installation of a Conqueror V-1570-11 in August 1930. (A R Krieger collection)

One of 71 Consolidated-built O-19Cs, 'O' has a chequered ring cowling and wheel covers. (A R Krieger collection)

XO-6B, O-19 Series

Thomas-Morse, which saw much room for improvement in an aircraft designed from the outset as an all-metal structure, then produced a company-funded prototype designated XO-6B (25-440/P-503) with a Pratt & Whitney Wasp R-1340 radial, smaller overall dimensions than the O-6, revised wing bracing, fabric-covered wings and corrugated metal fuselage covering.

Following testing, four aircraft based on this design were ordered on 16 June, 1928. A prototype XO-19

The sole O-21 (28-403/P-575) was used to test the 600hp Curtiss Chieftain engine. (A R Krieger collection)

(28-400) with a 450hp Wasp R-1340-3 and 112US gal fuel capacity was flown in April 1929; two service test O-19s (28-401/P-543, 29-369) with 500hp R-1340-9s, and a similar O-19A (29-370/P-569) without the 88US gal main tank. Finally, the company's all-metal work was rewarded on 16 August, 1929, with a contract for seventy production O-19Bs (30-90/159) with the 450hp R-1340-7, 80US gal main tank, two 0.30in guns, and modified cockpits. The wings were fabric covered, with control surfaces covered with aluminium sheet. One (30-91) was tested at McCook as P-598 with the designation XO-19B.

However, the order came at the time of the Consolidated takeover and all the aircraft were completed at Buffalo from March 1930. A follow-on order was placed on 12 June, 1930, for seventy-one O-19Cs (31-278/348) with a ring cowling and tailwheel and thirty O-19Es (31-523/552) in February 1931 with the 575hp R-1340-15 and extended-span upper wings. The sole O-19D was an O-19C (31-279) converted as a staff transport for the Secretary of War with dual controls and O-19E wings and engine.

The O-19s were delivered to four squadrons in the United States and four overseas observation units in the Philippines, the Canal Zone, and Hawaii.

Together with the production models of the O-19, there were a number of experimental versions based on the same airframe with different engines. Both ordered on 20 December, 1928, were the O-20 (28-402/P-561) with a 525hp Pratt & Whitney Hornet R-1690-1; and the O-21 (28-403/P-575) powered by a 600hp Curtiss Chieftain H-1640-1. The latter was subsequently redesignated XO-21A with a 525hp Wright Cyclone R-1750-1. The YO-23 (29-352) ordered on 3 November, 1928, had a 600hp water-cooled Curtiss Conqueror V-1570-1 and was tested at McCook in September 1929 as P-562. The Y1O-33 was converted from an O-19B (30-90) in August 1930 with a Conqueror V-1570-11 and revised tail surfaces.

A sesquiplane development of the Y1O-33 with a 600hp GV-1570-29, first flown on 4 May, 1931, was originally known as the XO-932, then the Y1O-41 and tested at Wright Field in June, reaching 195mph. No contract was received however, and the stripped airframe was re-acquired by Consolidated and rebuilt as the Model 23 in September 1934. Again it was unsuccessful in a competition with Douglas and once again put into storage. In August 1935, following another rebuild, it was registered NR33Y to Consolidated as a company 'hack'. With the help of Clint Warner, it was sold in Mexico as XA-BDX in December 1936. The new owner was Col Alfredo Lezama Alvarez, an agent for Spanish Republican interests, but there is no evidence that the Model 23 reached Spain.

One O-19B (30-127) survives today in the USAF Museum.

O-19B

One 450hp Pratt & Whitney Wasp R-1340-7 nine-cylinder air-cooled engine.

Span 39ft 9in; length 28ft 4in; wing area 348sq ft.

Weight empty 2,722lb, gross weight 3,800lb.

Maximum speed 139mph at sea level; cruising speed 121mph; climb 1,200ft/min; 10,000ft/11min; service ceiling 20,500ft, range 462 miles (82US gal fuel capacity).

Model 23

Span 29ft 9in; height 11ft; wing area 215sq ft.

Maximum speed 191.8mph; climb 10,000ft/6 min; fuel capacity 135US gal.

The O-23 (600hp Conqueror V-1570-1) was tested at McCook Field in September 1929 as P-562. (A R Krieger collection)

A Conqueror-powered sesquiplane development of the O-19, the XO-932 (Y1O-41) subsequently became the Consolidated 23 and was sold in Mexico.

Thomas and Thomas-Morse Selected Projects

XP-13 Viper

In response to the Army's interest in a biplane fighter using the new 600hp Curtiss Chieftain H-1640-1 twelve-cylinder twin-row engine, Thomas-Morse produced the Viper. The wings were of wooden construction with fabric covering and ailerons of corrugated metal sheet. Corrugated aluminium alloy covered the metal fuselage frame and the tail surfaces were of metal and fabric with the control surfaces corrugated sheet metal.

The Viper was tested at Wright Field in June 1929 (as P-559), then purchased by the Army and designated XP-13 (29-453), but the engine suffered insurmountable cooling problems. Therefore, in September 1930, it was re-engined with a 450hp Pratt & Whitney Wasp SR-1340C radial in a NACA cowling along with a revised fin and rudder. In this form it was redesignated XP-13A and was found to be 15mph faster than the XP-13. A USAAC performance report of 1930 described it as having 'a comfortable feel' in all aerobatics and 'makes a wonderfully smooth slow roll.' The XP-13A was destroyed in a crash following an inflight fire.

Span 28ft 0in; length 23ft 6in; height 8ft 5in; wing area 189sq ft.

Weight empty 2,262lb (XP-13); 2,224lb (XP-13A); gross weight 3,256lb (XP-13); 3,194lb (XP-13A).

Maximum speed 173mph (188.5mph, XP-13A); cruising speed 138mph (150mph XP-13A); climb 5,000ft/3min (3.5min XP-13A); service ceiling 20,775ft (24,150ft XP-13A).

BP

Twin 186hp tractor-type 'battleplane' with pilot and two gunners in central nacelle, twin booms and tail. Two seaplanes designated Type S for Navy (BuA-140/141) were cancelled.

Span 44ft; length 28ft 9in; wing area 440sq ft.

Gross weight 2,860lb.

(Estimated) Maximum speed 81mph; climb 330ft/min; endurance 4.5hr.

Y1O-42

Single-engined high-wing monoplane initially designated XO-924; although no production was undertaken, an unserialled fuselage was completed and delivered for static tests in 1932.

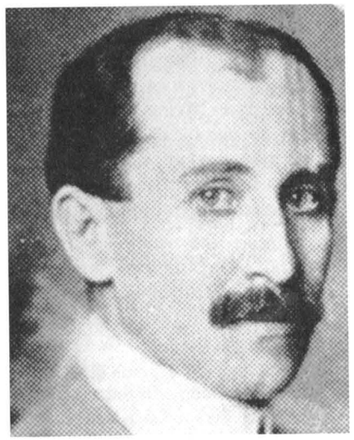
The final Thomas-Morse design was the XP-13 Viper (600hp Curtiss Chieftain H-1640-1). (Wright Field)

Dayton Wright

In 1915, Orville Wright[1] sold his Dayton factory and patents to the Simplex Automobile Co syndicate and the next year entered into a period of informal collaboration with Charles F 'Boss' Kettering, inventer of the automobile self-starter and president of the Dayton Engineering Laboratories Co (Delco). Later in 1916, Kettering organised the Dayton Wright Co[2] with three associates; Edward A Deeds (later the head of National Cash Register); Col Harold E Talbott, a paper mill, power plant, and munitions industrialist; his son Harold E Talbott, Jr, (later Secretary of the Air Force); together with Orville Wright as consulting engineer. The company built a wind tunnel and laboratory for Wright, two hangars, a small machine shop and a woodworking shop on Deeds Field, near Deed's home in Dayton.

With additional capital supplied by a Detroit automobile group, the enterprise was incorporated as the Dayton Wright Airplane Company on 9 April, 1917, three days after the United States entered the war. Shortly afterwards, Deeds resigned from the company to serve on the Aircraft Production Board. Commissioned as an Army colonel, he became chief of the equipment division of the Signal Corps Aviation Section.

In that capacity, Deeds sent the first de Havilland DH-4 to arrive in the USA to Dayton Wright for study in July 1917. Modified to accept the new Liberty twelve-cylinder water-cooled engine and US-built 0.30in Marlin machine-guns, it was test flown on 29 October by Howard M Rinehart, a former pupil of Orville Wright and company test pilot.



Orville Wright had been president of the Wright Company from 1912 to 1915, and gave his name to the Dayton Wright organisation in 1917. (Aircraft Year Book)

Dayton Wright was awarded contracts for 5,000 DH-4s and 400 Standard J trainers, which gave it the largest dollar volume ($31.5 million) of any manufacturer the Army dealt with. The first nine DH-4s were completed in February 1918 and at the peak of operations, forty aircraft were built per day and the company employed 8,000 at three plants. Plant No.1 was at Moraine City, four miles from Dayton, and had originally been intended for use by the Domestic Engineering Company of Dayton for the manufacture of Delco Light Products. All assembly work was completed at this factory and aircraft were test flown from nearby Deeds Field (which became known as the South Field Experimental Station)[3]. The other plants, No.2 at Miamisburg, eight miles south, and No.3 at the original Wright Airplane Company's building in Dayton, were used for parts manufacture. However, by May 1918, Deeds was under investigation by the Justice Department in connection with these favourable contracts to his former company.

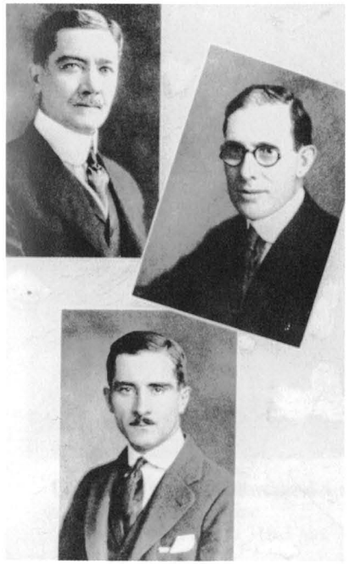
An interesting project was the 'Bug' biplane, designed as an unmanned flying bomb. Tests were reasonably successful and a production contract authorised but cancelled upon the signing of the Armistice. A man-controlled aircraft was designed by Oliver W Thomas, who had joined Dayton Wright from his own company, to test the Bug's DePalma-built engine.

At the end of the war, the remaining DH-4 deliveries were cancelled (3,098 Dayton Wright-built aircraft had been delivered, including 155 for the Navy, and between 1,800 and 2,000 reached France) and the company retrenched to one plant at Moraine City Field.

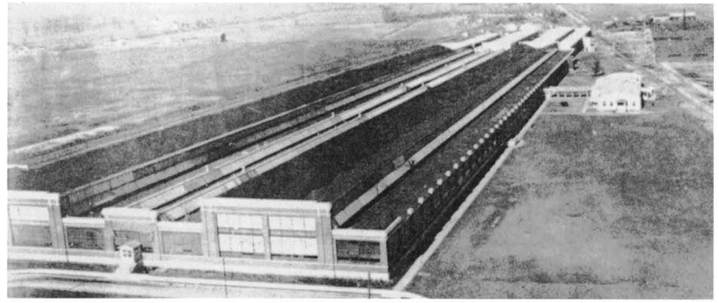
1 The Wright Company of New York, Albany, was incorporated on 22 November, 1909, with Wilbur as president and Orville and Andrew Freedman as vice-presidents. Capital was one million dollars, contributed by Cornelius Vanderbilt, Howard Gould, August Belmont, Theodore P Shouts, E J Berwind, Robert J Collier, Andrew Freedman, Morton S Plant, Allan A Ryan, and Russell A Alger. On the death of Wilbur in 1912, the post of president was assumed by Orville, a position he held until the company was sold in 1915.

2 The style Dayton-Wright was also used, especially postwar.

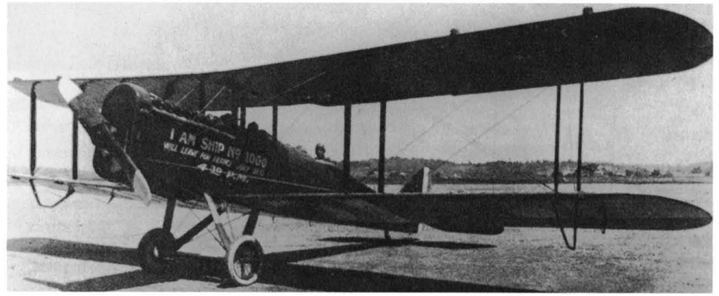
3 Deeds and Kettering also owned North Field, which later became the Army's McCook Field.



Three of the key businessmen behind Dayton Wright; from top, Col H E Talbott, Charles F Kettering, and H E Talbott Jr. (Aircraft Year Book)



Main Dayton Wright plant was the former Delco factory at Moraine City, Ohio. (Aircraft Year Book)



By far the most widely-produced design by Dayton Wright was the DH-4. This is the 1,000th example, suitably marked for publicity photographs. Completed on 31 July, 1918, it arrived in France on 7 September. (Aircraft Year Book)

Dayton Wright also built three USD-9As (equivalent to the D.H.9A). In 1919, automotive giant General Motors acquired the company for $1,096,000 in debenture stock, thus making Dayton Wright a subsidiary and dropping the word Airplane from the title. With the cancellation of government contracts, Dayton Wright attempted to find a market for the vast number of surplus DH-4s by offering conversions to cabin aircraft, 'in order to dispose of unsightly flying togs,' and build in more range because of the lack of adequate landing fields. To supplement its now meagre income, a flying school was also opened. During the latter part of the war, Dayton Wright had delivered two modified DH-4s, the DH-4A with a 110US gal fuel system, and the DH-4B with an 88US gal tank in front of the pilot and the undercarriage moved forward. Many of the latter conversions were made postwar on behalf of the Air Service and the Air Mail Service.

In June 1919, Orville Wright wrote 'the expense involved in putting the aeroplane business on a sound commercial basis will be such that small, if any, dividends are likely to come from it for some time. I therefore send in my resignation, in so far as salary is concerned, without withdrawing from any of the duties as consulting engineer.'

Besides DH-4 modification work, Dayton Wright built forty-four Engineering Division XB-1As for the Air Service. These were plywood fuselage versions of the Bristol F.2b Fighter with a Wright-Hispano engine. The company also produced a handful of original designs including the FP-2 seaplane and radical RB Racer, but the most promising designs were the TA-3 and TW-3 basic trainers. Designed by Col Virginius 'Ginny' Evans Clark, the Army's chief aeronautical engineer until he left McCook Field in 1920 to join the General Motors aviation subsidiary, the side-by-side, two-seat military trainers had been developed from the civilian Chummy. However, General Motors was disillusioned with the aircraft business and by early 1923 was ready to close down the subsidiary and build cars instead.

An offer for the Dayton Wright trainer designs was made by Reuben Fleet, now in charge of Gallaudet, and confirmed in writing on 13 April, 1923. An agreement was signed on 9 June, which included the services of Clark. Five days later an order for twenty TW-3s plus enough spares for three more, worth $200,000, was placed by the Air Service with the Consolidated Aircraft Corp. On 3 July, one TA-3 was delivered to the new company by Dayton Wright along with all the plans and tooling for the TW-3s. Built at the Gallaudet factory on Rhode Island, the TW-3 was developed into the Consolidated PT-1.

Dayton Wright was dissolved by General Motors in 1923, but as a footnote, GM returned to the aviation industry in May 1929, when it acquired 40 per cent of the stock in the Fokker Aircraft Corporation. Charles Kettering, then a vice-president with GM, became a director. Kettering had also become a director of United Aircraft and Transport Corporation in 1928, along with Edward A Deeds. Today, the only known remaining aircraft built by Dayton Wright are a DH-4B (N-489) in the USAF Museum at Wright Patterson AFB, Ohio, and the RB Racer in the Henry Ford Museum, Detroit.

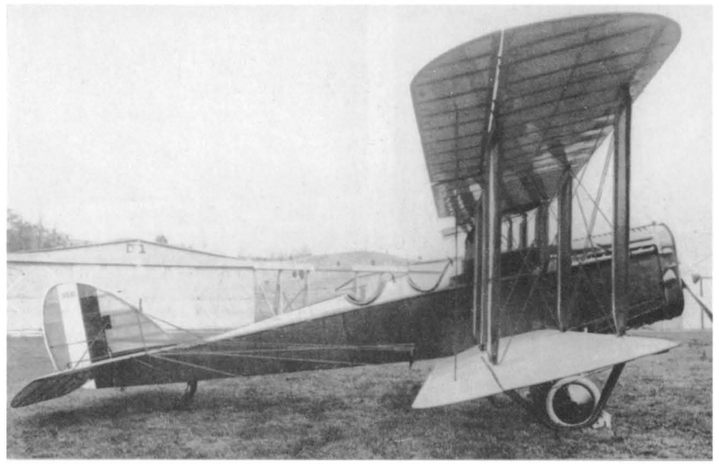
Dayton Wright Aircraft Production Summary

Standard J	400
DH-4	3,098
USD-9A	3
DH-4K Honeymoon Express*	0
O.W.-1 Aerial Coupe	1
K.T. Cabin Cruiser	4
Bug testbed	1
T-4 Messenger	1
XB-1A	44
WA	1
WS	1
DT-2**	11
SDW-1*	0
RB Racer	1
FP-2	2
XPS-1	3
Chummy	2
TA-3	4
TA-5	1
TW-3***	23
TOTAL	3,601

* Conversions

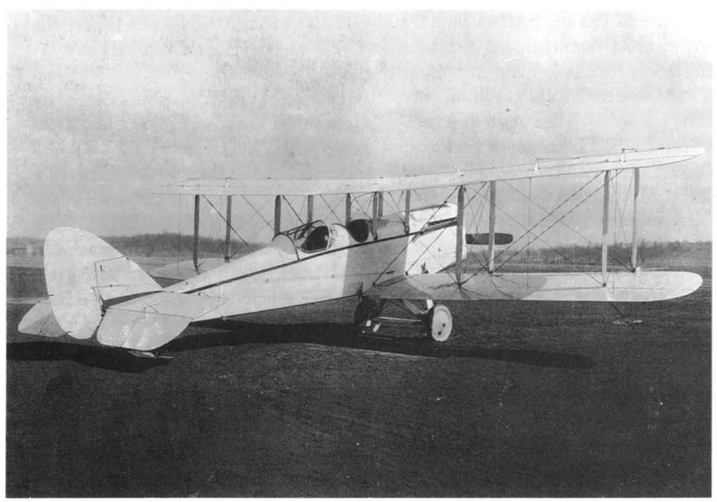
**Douglas designed.

***Three prototypes built by Dayton Wright, twenty production aircraft built by Consolidated at the Gallaudet factory, Rhode Island.



Nine Hour Cruiser (30130) with enlarged tank between the Liberty engine and cockpits. (Aircraft Year Book)

This Dayton Wright conversion of a DH-4 is believed to be the Honeymoon Express. In any event, it has an enclosed rear cockpit seating two in tandem. (Peter M Bowers collection)



Dayton Wright Aircraft

DH-4 Conversions

During the war, Dayton Wright received contracts for 5,000 DH-4s following modification of a pattern aircraft sent from Britain to accept the Liberty 12 engine and American 0.30in Marlin machine-guns. The final total of DH-4s delivered was 3,098, the rest being cancelled. In addition, there were substantial numbers remodelled or converted to DH-4A or DH-4B standard and 155 were transferred to the Navy and Marine Corp with the designation O2B.

Dayton Wright also built the DH-4R, an unarmed advanced trainer conversion with dual controls, modified rear decking, and the gunner's position modified to an instructor's position. At least one Nine Hour Cruiser was completed, a DH-4 (30130) with an enlarged fuel tank positioned directly over the undercarriage, aft of the Liberty engine and ahead of the two open cockpits. With double the normal endurance, nonstop flights were claimed possible between New York and Chicago. The D.W.H. 4 Blue Bird was a dual-control trainer version, with the same modifications, produced in small numbers for the Army.

Three USD-9As (equivalent to the D.H.9A) were also built (40044, 40118/40119) and the second was tested at McCook Field with the number P-80.

The first postwar civil conversion offered was the DH-4K Honeymoon Express, a three-seat sport conversion of a DH-4B with a 1ft longer fuselage, displayed at the Aeronautical Exhibition, Madison Square Garden, New York City during 1-15 March, 1919. The two passengers were carried in an enclosed cabin behind the pilot's open cockpit and it was powered by a 400hp Liberty 12. One aircraft (race number 32) was entered in the Aviation

O.W.-1 Aerial Coupe used the wings and basic frame of the DH-4, but had a four-seat cabin. (Air Force Museum)

Country Club Trophy Race at the Pulitzer Races, Detroit, in October 1922. Piloted by Lt H R Harris of the USAAC, it won against three other competitors.

One 400hp Liberty 12 twelve-cylinder water-cooled engine.

Span 42ft 5$^{1}/_{2}$in; length 31ft 1$^{1}/_{2}$in; height 11ft 9in.

Weight empty 2,400lb; gross weight 3,410lb.

Maximum speed 115mph; climb 10,000ft/10min; endurance 2.25hr (88US gal fuel capacity).

In 1919, Orville Wright designed the O.W.-1 Aerial Coupe, a three-passenger cabin design based on the DH-4 with a 180hp Wright-built Hispano-Suiza E or Packard 8. The advertising brochure described it as 'luxuriously finished, combining comfort and beauty with safety.' The entrance for the pilot, who also sat in comfort, and the passengers was through a full-size door in the cabin side which bisected the upper longeron. Thus, usual longeron stress was carried up and over the door frame. A five-hour endurance was claimed at 87mph (350-400 miles). Shown at air exhibitions in Chicago, New York, and San Francisco in 1920, the sole aircraft established a new American altitude record on 22 May when B L Whelan carried three passengers to 19,710ft over McCook Field. The three-passenger record was popular in 1920, the OW broke one set at 17,150ft five days earlier, but itself was beaten four days later by an Army aircraft topping 20,000ft. Another publicity gimmick was the delivery of ice-cream from Cleveland to Washington for the banquet of the Retail Ice Cream Dealers' Association on 30 May. The O.W.-1 was sold to J G Montijo, California.

An early example of the K.T. Cabin Cruiser, lacking any forward vision for the pilot. (Air Force Museum)

Span 46ft; length 28ft 6in; height 9ft 9$^{1}/_{2}$ in; wing area 534sq ft.

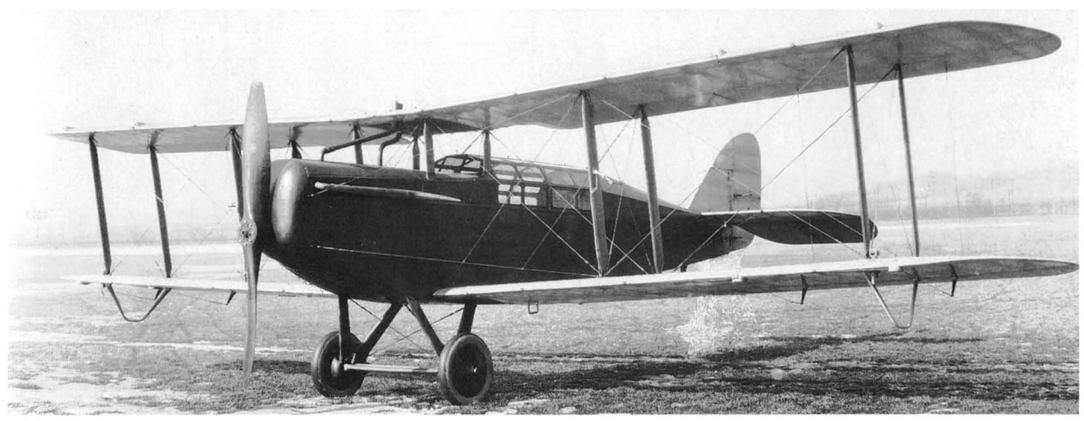
Weight empty 1,450lb; gross weight 2,492lb.

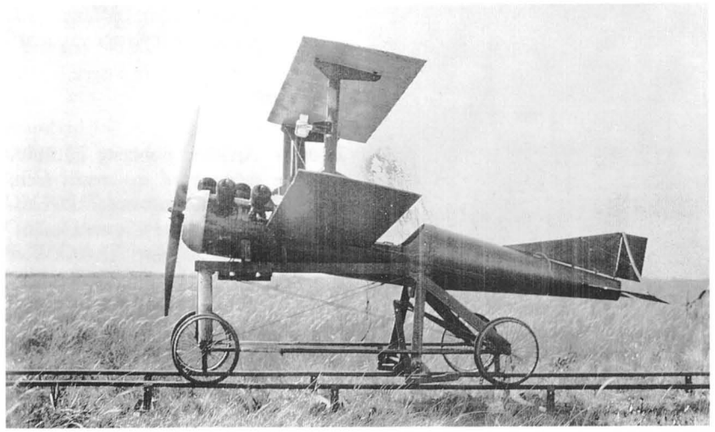
Maximum speed 95mph; range 500 miles (70US gal fuel capacity).

K.T. Cabin Cruiser

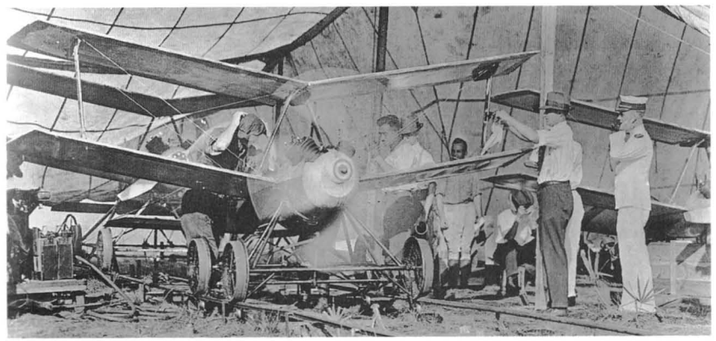
The K.T. Cabin Cruiser (K.T. = Kettering and Talbott) was another three-seat cabin conversion, with the pilot seated with the passengers, and featured a typewriter table and thermos bottle containers together with a six-hour endurance at 125mph. As the ex-

Later version of the K.T. Cabin Cruiser. (Air Force Museum)





A Bug on its launching framework. (Peter M Bowers collection)



port of Liberty engines had been banned, the Packard 12 was offered for overseas deliveries. The first, shown at the New York show in 1920, had no forward view for the pilot. At least three more were similarly converted but with improved cockpit glazing that offered a forward view. One was still owned by the company in 1922.

A Bug about to be launched during trials as NAS Pensacola, Florida. (Peter M Bowers collection)

Span 43ft 7½in; length 30ft 1½in; height 11ft 2½in; wing area 441sq ft.

Weight empty 2,686lb; gross weight 4,128lb.

Maximum speed 120mph; endurance 6hr (128US gal fuel capacity).

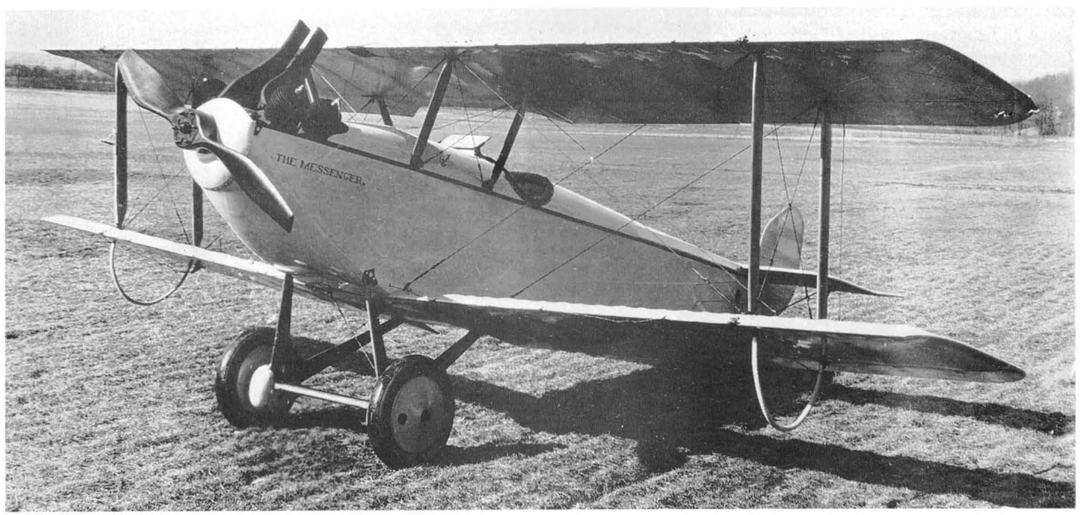
Bug

A few months after the United States entered the Great War, a scheme was devised to spring a surprise attack on German cities and industrial targets behind the front line using large numbers of unmanned flying bombs. By this action, it was hoped that morale would be broken and the conflict brought to a swift conclusion.

The Aircraft Production Board issued specifications in great secrecy in early October 1917 to three manufacturers, Dayton Wright, Curtiss, and Lawrence Sperry. The requirements were simple, a small self-controlled aircraft capable of flying 200 miles, carrying 200lb of explosives, with the cost not to exceed $200 each. The trajectory had to be predetermined on the ground and an electrically-driven gyro controlled the direction of flight, an altimeter the height, and a subtracting anemometer the distance. A speed of over 100mph was desired but not specified.

Initial studies were undertaken by Fred Nash and Orville Wright designed a small biplane which came to be known as the Bug. Constructed of scrap aircraft spruce, plywood, and paper, the Bug could be assembled in five minutes by two men with a screwdriver and spanner. Initially, a two-cylinder engine was planned for the Bug, but this idea was abandoned in favour of a 37hp four-cylinder engine designed by Dayton Wright and built by the DePalma Manufacturing Co. This drove a 5ft diameter wooden propeller and the control surfaces through a system of valves and bellows.

T-4 Messenger (37hp DePalma). (Air Force Museum)



XB-1A 64158/P-179 at McCook Field. (McCook Field)

Early in 1918, Kettering decided to build a man-carrying biplane to test the new engine and a lightweight single-seater was designed by O W Thomas, formerly of Thomas Brothers, and now with Dayton Wright. The aircraft was built at South Field and flown by Howard Rinehart in early spring. However, the engine was unsuited for manually-controlled flight and the testbed was quickly abandoned.

Test flights with Bugs started in late spring, launching Bugs from a car driven on a track, and in calm air the Bug flew well at 120-125mph. After inspection by the Army, at least twenty Bugs were sent to NAS Pensacola for trials and 'shot' at anchored targets 90 miles away in the Gulf of Mexico. Evidently, these were successful and a contract for full-scale production awarded but the signing of the Armistice caused the Bug's cancellation.

Span 15ft; length 12ft.

T-4 Messenger

Based upon experience with the man-controlled Bug testbed, the single-seat Messenger was similarly-powered by a 37hp DePalma four-cylinder air-cooled engine. The fuselage consisted of longerons with veneer sides and wooden strips instead of wires. The sole aircraft built was shown at the Aeronautical Exhibition, Madison Square Garden, New York City, during 1-15 March, 1919, but development was abandoned later in the year. Contemporary reports refer to it as an intended army liaison type adapted for civil use.

Span 19ft 3in; length 17ft 6in; height 6ft 1in; wing area 106sq ft.

Weight empty 385lb; gross weight 636lb.

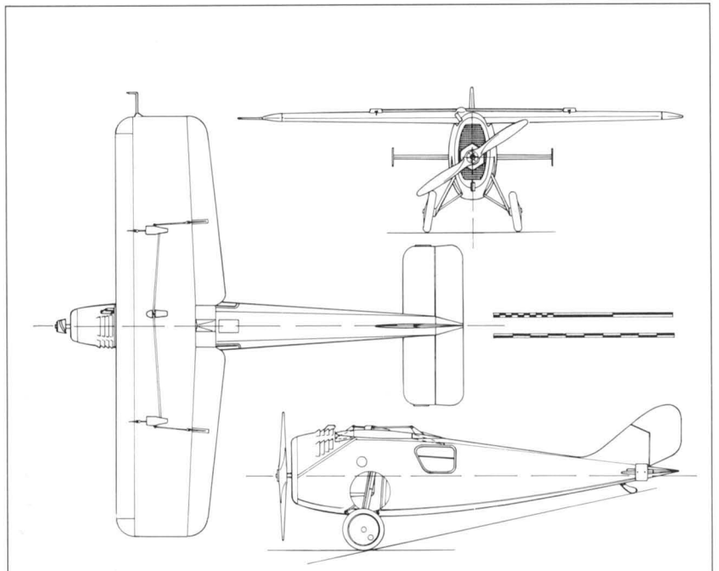
Maximum speed 85mph, climb 3,000ft/10min; endurance 2.5hr (12US gal fuel capacity).

XB-1A

The United States had received a sample Bristol F.2b Fighter in September 1917 and immediately started work to convert it with a Liberty 12 engine. This resulted in an aircraft weighing 3,600lb and the programme had been abandoned after twenty-seven were completed by Curtiss. Instead, lighter engines were adopted including the 300hp Wright-Hispano and the Liberty 8.

At McCook Field, the Engineering Division designed a new plywood fuselage, lighter and stronger than the original, and with the 300hp Wright-

RB Racer (racing number 2) at the Gordon Bennett Races at Étampes, France, in September 1920. (Stephen J Hudek collection)



Dayton Wright RB Racer

Hispano H engine the conversion was known as the XB-1A. Armed with two Browning and two Lewis guns, three Engineering Division prototypes were built, the first flying on 3 July, 1919. Dayton Wright completed four more (64115/P-171, 64300/P-180, 94107/P-150, and 94108/P-151). These were followed by a contract for forty XB-1As (64156/64194, 64300) placed with Dayton Wright on 28 June, 1920. Four of these were tested at McCook (64158/P-179), 64160/P-181, 64161/ P-182, 64177/P-205) and two were transferred to the Navy (BuA 5974/5975). The others were assigned to the 12th Observation and 13th Attack Squadrons in Texas.

Span 39ft 4in; length 25ft 6in; height 9ft 10in; wing area 406sq ft.

Weight empty 2,155lb; gross weight 3,791lb.

Maximum speed 130mph; cruising speed 101mph; climb 6,500ft/7.5 min; service ceiling 18,900ft; range 495 miles/4hr at 10,000ft (100US gal fuel capacity).

RB Racer

Designed in 1920 by Milton C Baumann for that year's Gordon Bennett Cup race in France, this compact monocoque-fuselage monoplane had a number of advanced features for its day. Built out of solid balsa covered with plywood and varnished linen, its cantilever wings had variable camber, achieved through the use of hinged leading and trailing edges. In its original configuration, two sets of actuating control rods were mounted on each side of the upper wing surface, but this was reduced to a set either side for the race. The camber control wheel was mounted in the cockpit and linked directly to a chain and sprocket driven retractable undercarriage. Powered by a 250hp Hall-Scott Liberty six-cylinder water-cooled engine, the pilot sat inside the deep plywood-built fuselage and entered via a trapdoor above the cockpit. Only two side windows were provided, but these could be opened for landing by the pilot by leaning his shoulder against the back of the frame and pushing forward.

By far the cleanest of four designs entered in the race by the United States, the RB Racer reached 165 mph during a practice lap at Étampes-Ville-sauvage. Flown by Howard M Rinehart, it developed mechanical trouble at the start of the race on September 28, and had to be withdrawn. Rinehart reported that he could not turn to port, possibly because of a broken rudder cable. However, he was also unable to crank the wing to its high-speed position and, as the undercarriage retracted with the wing change, the wheels could not be fully withdrawn into the fuselage.

The basic design layout was developed into the XPS-1 and the sole RB Racer is now in the Henry Ford Museum, Detroit.

One 250hp Hall-Scott Liberty six-cylinder water-cooled engine.

Span 21ft 2in; length 22ft 8in; height 8ft 0in; wing area 102.7sq ft.

Weight empty 1,400lb; gross weight 1,850lb.

Maximum speed 195mph (designed); ceiling 15,000ft; range 275 miles (1.5 hr endurance).

XPS-1

Generally similar to the RB Racer, the XPS-1 (Pursuit, Special Alert) had a rotund steel tube, fabric-covered fuselage to accommodate a 200hp Wright J-l (Lawrance-type) air-cooled radial, a four-bladed propeller, and a wooden variable-camber parasol wing. The hand-operated main undercarriage could be lowered in six seconds and raised back into wheel wells in just ten seconds.

Three XPS-1 prototypes were ordered by the Air Service in June 1921 (68534/68536), two with the J-1 and the last with a Wright E engine. The first was intended for static tests but was inspected and apparently flown at McCook Field in November 1922. Several defects in the undercarriage design were noted, the compression tube interfered with the pilot's legs, the holes in the fuselage sides for the wheels were likely to cause ingestion of water and debris leading to failure of the system, and the pilot's hands were in danger of injury by the latch of the undercarriage control wheel and the chain drive. In addition, a new exhaust system was required because of fumes escaping into the cockpit. In the event, the initial performance requirements could not be met and the military specification was lowered to 130mph at 15,000ft and a climb to 20,000ft within 25 minutes.

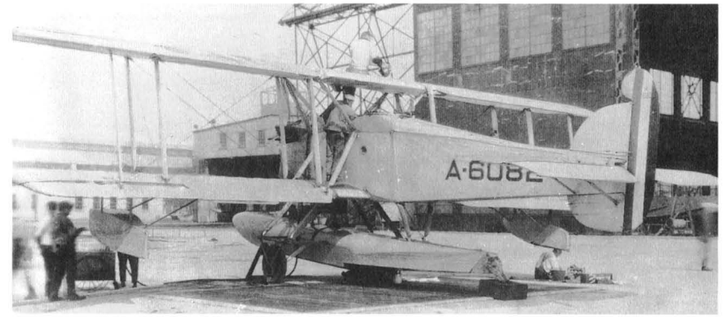
The second XPS-1, 68535 (P-308), at McCook Field. (McCook Field)

The second aircraft incorporated most, if not all the required changes, but when flown in July 1923 (with McCook Field number P-308) could not meet the performance requirements because the powerplant was still unsatisfactory. The third (tested as P-311) was also rejected by the USAAS and both were placed in storage at McCook. One was still extant on 30 April, 1926.

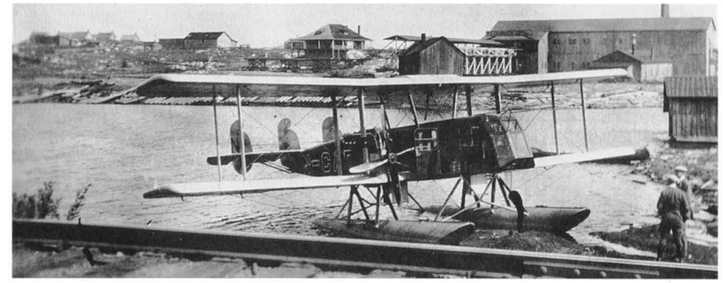
The XPS-1 was the first military aircraft with a retractable undercarriage (the James V Martin-designed K-111 Scout of 1917 was not used by the Army) but was overtaken by developments with the Verville-Sperry R-3.

Span 30ft 0in; length 19ft 2in; height 7ft 0in; wing area 143sq ft.

Gross weight 1715lb.



WA A-6082 (200hp Wright E-4). (A R Krieger collection)



FP-2 N-CAED at Biscoe, Ontario, in 1922. (Ontario Dept of Lands & Forests)

W Series

One WA two-seat 'shipboard' seaplane with a large float underneath the fuselage and a smaller float beneath each wing, powered by a 200hp Wright E-4, was built for the Navy (A-6082). Another similar aircraft, designated WS, was also completed (BuA-6083). One WD (BuA-6084) was cancelled and serials A-6085/6102, reserved for the WA/ WD/WS series, were not taken up.

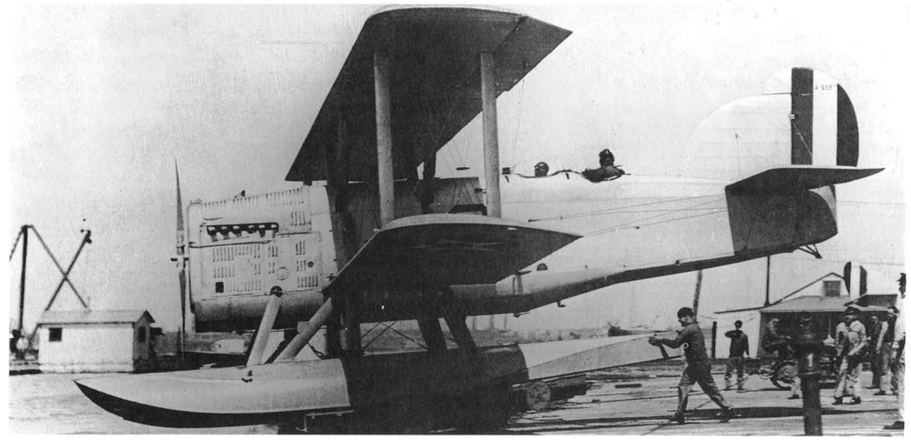
Span 40ft 9in; length 34ft 4½in; height 18ft.

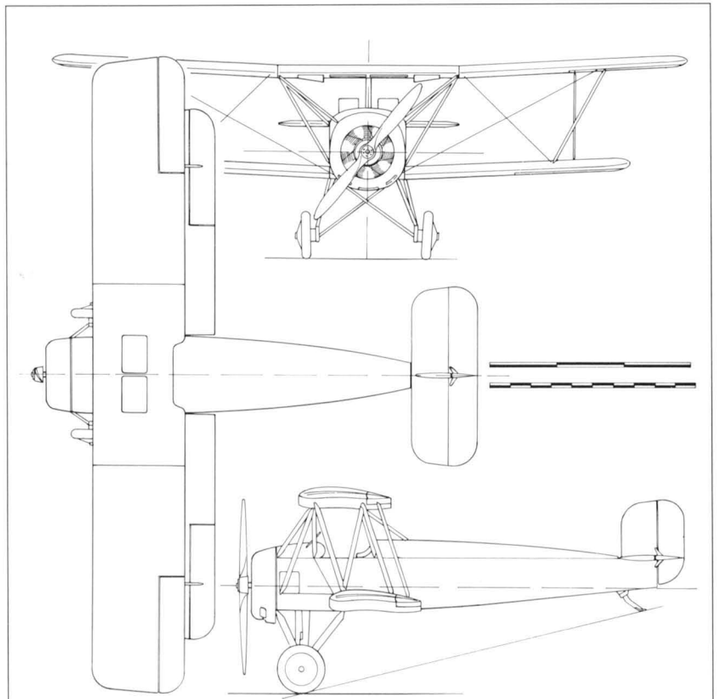
Maximum speed 110mph.

DT-2 and SDW-1

Eleven Douglas DT-2 two-seat biplane torpedo carriers each with a 420hp Liberty 12A engine were ordered from Dayton Wright for the Navy (BuA-6085/6095) in 1922. Another three LWF-built aircraft (BuA-6593, 6596/6597) were modified by Dayton Wright with a deeper fuselage

SDW-1 A-6597 coded '2'. (Peter M Bowers collection)





Dayton Wright TA-3

housing extra fuel as long-range three-seat scouts, with the non-Navy designation SDW-1.

The first TA-3, 64390, (80hp Le Rhône) at Mc-Cook Field. (McCook Field)

Span 50ft; length 37ft 8in; height 15ft 1in; wing area 707sq ft.

Weight empty 4,528lb; gross weight 7,293lb.

Maximum speed 99.5mph at sea level; climb 3,850ft/10min; service ceiling 7,400ft; range 274 miles (with 1,825lb torpedo).

FP-2

This four-seat twin-float cabin seaplane was designed at the request of the Spanish River Pulp and Paper Co, Sault Ste-Marie, Ontario, Canada, for forestry patrol (hence the designation) in 1922. Originally, the FP-2 had twin Hall-Scott L-6s with pusher propellers, but this was changed to a tractor arrangement with 400hp Liberty 12 engines.

The fabric covered wooden upper and lower wings were interchangeable and steel tubing was used for the interplane support struts. The fuselage was built of spruce longerons and veneer bulkheads, covered with three-ply consisting of balsa sandwiched between black walnut, and supported a triple tail. The cabin was reached from the floats by a folding ladder and there were emergency exits in the roof. Windows were also installed in the lower forward fuselage and the two front seats could be swivelled to face the others, with a table in-between.

Although two were ordered, only one has been confirmed as completed. Registered in the USA as N-CAED, it was severely damaged while taking off from Michipicoten Harbour, north of Sault Ste-Marie, on 28 September, 1922, when a float bracing wire failed. The pilot was J Scott Williams.

Span 51ft 5in; length 36ft 10$^{1}/_{4}$in; height 13ft 11$^{1}/_{2}$in; wing area 688sq ft.

Weight empty 5,726lb; gross weight 7,588lb.

Maximum speed 120mph; climb 5,000ft/10min; range 325 miles.

Chummy, TA-3, TA-5 and (Consolidated) TW-3

Designed by Col Virginius Clark, the Chummy was a side-by-side two-seat sporting biplane with an 80hp Le Rhône and made extensive use of steel tubing for the fuselage structure, tail unit, interplane struts, and split-axle type undercarriage. The Clark Y aerofoil wings were of wooden construction with fabric covering and upper and lower sets were interchangeable. In addition, the same assembly could be used for the rudder or either elevator. Two Chummy aircraft were on strength with the manufacturer in 1922, one with a 120hp Clerget instead of the Le Rhône.

In 1921, the design was submitted to the Air Service as a replacement for the OX-5-powered Curtiss JN-4D. Three aircraft, designated TA-3 (Trainer, Aircooled) with the 80hp Le Rhône, were ordered and tested at McCook Field. (64390/P-230, 64391/P-239, 64392/P-262) and proved satisfactory except for being underpowered. One TA-3 (P-239) was tested with a 110hp Le Rhône in January 1923, and as a result ten production TA-3s (22-266/275) had a similar engine (the last Army type to have a rotary engine) and the first was tested as P-276. One TA-3, possibly a prototype, was delivered to Consolidated on 3 July, 1923, and another was subsequently tested at McCook with a 90hp Le Rhône C-9 as P-407.

The TA-5 (68583) was an enlarged TA-3 with a 200hp Wright J-1 (Lawrance-type) engine used solely for test work at McCook, as P-283. One experiment replaced the normal undercarriage with a single landing wheel under the nose and outrigger-type smaller wheels on the wingtips.

As an alternative to the Rhône, three TW-3 (Trainer, Watercooled; 22-226, 22-401/P-273, 22-402) were completed with 150hp Wright-Hispano 1 engines. A production contract for twenty TW-3s (23-1300/1319), plus enough spare parts for three more, with the 180hp Wright E and a larger rudder (tested on P-273) was placed with Consolidated on 14 June, 1923. Work was started on these by the end of July at the Gallaudet factory on Rhode Island. Official service tests at McCook Field with a TW-3 (23-1309/P-338) were flown on 10 June, 1924, by Lt Eugene Barksdale. All aircraft had been delivered to Brooks Field, San Antonio, Texas, by the end of the year. One TW-3 was transferred to the Navy (BuA-6730) and tested at NAS Anacostia with a single main float and outrigger floats on the outer wings. After reverting to a wheeled undercarriage, it was used by the Marine Corps for mosquito spraying.

After the initial deliveries, the radiator design was simplified by Fleet himself but it and the cowling—discarded in service—restricted visibility from the side-by-side seat cockpit. Therefore, with the permission of the Army, one aircraft was modified by Consolidated with a narrower fuselage seating two in tandem and unofficially referred to at Brooks Field as the Camel because of the hump between the cockpits. This improved layout and other revisions were incorporated into the 'TW-8', an unofficial designation used during the competitive trials for a new trainer at Brooks Field during early summer 1924. Whether this was a new airframe, or the 'Camel' is not clear but an out-of-sequence serial (23-1253) has been quoted. Subsequently, this new design was ordered into production as the Consolidated PT-1 (Model 1).

The second TW-3, 22-401, (150hp Wright-Hispano 1) fitted with larger rudder adopted for production aircraft. (McCook Field)

One TA-3 and the TA-5 were still at McCook in 1927.

TA-3

80hp Le Rhône C air-cooled rotary engine.

Span 30ft 11$^{3}/_{4}$in; length 21ft 11$^{1}/_{4}$in; height 9ft 11$^{1}/_{2}$in; wing area 235sq ft.

Weight empty 1088.5lb; gross weight 1,693lb.

Maximum speed 83.8mph at sea level; initial climb 537ft/min, 7,500ft/21.7min; service ceiling 10,000ft; endurance 2.5hr.

Dayton Wright Projects

O-3

Two-seat biplane with 645hp Wright T3 (V-1950), prototype XO-3 cancelled (23-1254).

Consolidated Aircraft Corporation

When Reuben Hollis Fleet founded his Consolidated Aircraft Corporation in May 1923 he was 36 years old, yet was already a self-made businessman and ex-legislator with six years experience in the US Army Air Service. Fleet was to rule Consolidated almost single-handedly for 18 years and brought the fledgling company to be one of the largest aircraft manufacturers in the country.

Fleet was born on 6 March, 1887, in Montesano, Washington, a descendant of the Fleets of London. His father was a timber buyer who had reached the Pacific Northwest from Kansas City by foot, horseback and stage coach. After Fleet finished grade school he entered the Culver Military Academy (headed by his uncle) in Indiana, graduating in 1906. For a brief period, Fleet was a school teacher in rural Washington then started his own business as a timber appraiser and real estate dealer in his hometown. At the same time he joined the Washington National Guard.

His first taste of flying came in 1914, with a flight in Terah T Maroney's flying-boat on Lake Washington. Fleet was an immediate convert and from then on flew at every opportunity. In 1915, as the youngest member of the State Legislature, he circled the dome of the capitol in Olympia for 35 minutes in a flying-boat flown by Al Stromer. Fleet then introduced a bill appropriating $250,000 for aviation training in the National Guard (this amount exceeded the $225,000 appropriation Congress had voted for the entire country). As Fleet expected, passage of the bill in the lower house attracted national attention but he let the measure die after the Aviation Section of the Army Signal Corps agreed to press Congress for funds to train one guardsman from each state annually.

Reuben Hollis Fleet, founder of Consolidated Aircraft (Gittings via San Diego Aerospace Museum)

Fleet was among the eleven to be chosen for pilot training in the new programme in 1917 and made his first flight from North Island, San Diego, on 5 April. The next day the United States was at war. After becoming Military Aviator No.74, Fleet spent most of the time at Signal Corps aviation headquarters in Washington, DC, as executive officer for flying training. In May 1918, on the recommendation of Col H H 'Hap' Arnold, Fleet was named Officer-in-Charge of the Aerial Mail Service, which the Post Office Department had sprung onto the Air Service with just twelve days notice. In October, Fleet accompanied Arnold on a visit to Britain and attended Smith-Barry's school at Gosport.

On his return to the USA, Fleet went to McCook Field, Dayton, the home of the Engineering Division. During the immediate postwar years, the Division promoted the advancement of aviation through a programme of original design, prototype construction and rigorous testing. Fleet remained there from January 1919 until autumn 1922 as business manager and contracting officer for the Air Service. Also at McCook was Isaac Machlin 'Mac' Laddon, head of large aircraft design in Section Two.

When Fleet decided to leave the Air Service on Thanksgiving Day (30 November) 1922, he turned down executive jobs with Boeing and Curtiss to become general manager of the Gallaudet Aircraft Corporation at the invitation of president Kelly Robinson and investor Harry Payne Whitney. Realising that there was little in the way of practical aircraft projects at Gallaudet, Fleet cast around for other opportunities, in particular training-type aircraft in which he had long been interested.

One design that held promise was built by the Dayton Wright Company, which had been a neighbour at McCook. Designed by chief engineer Col Virginius 'Ginny' Evans Clark (who had been the Army's chief aeronautical engineer at McCook until 1920), the original TA-3 Chummy had been developed into the TW-3 and the Air Service appeared likely to place an order. However, the company's parent, General Motors, was disillusioned with the aircraft manufacturing business and wished to close the money-losing subsidiary.

Thus, Fleet negotiated for the patents and manufacturing rights to the trainers and the services of Clark. Failing to reach an agreement with the Gallaudet investors for a jointly-owned company, Fleet promptly incorporated Consolidated Aircraft Corporation in the state of Delaware.[1] On 29 May, 1923, an agreement was signed with Robinson for the lease of some Gallaudet facilities and workers at Greenwich, Rhode Island, to produce the TW-3 and on 14 June, Consolidated received an order for twenty aircraft. George Newman, previously with Gallaudet, became factory manager and Ray P Whitman chief inspector.[2]

Fleet's instinct was always to simplify designs and make the product safer and therefore improvements were made to the TW-3 that resulted in Consolidated's first design, the PT-1. A contract for fifty was placed by the Air Service in 1924 and with this in hand, Fleet looked for a more suitable production facility. He found it in Buffalo, New York, where he took over the North Elmwood Plant, a former Curtiss factory. Not only was there plenty of floor space, but there was also ample skilled labour available, left over from massive wartime contracts. A leasing contract was signed on 22 September, 1924, for 28,351sq ft of space with an option to expand if business warranted it (by 1931, Consolidated had 236,000sq ft of covered space). The first to arrive at Buffalo was not a Consolidated employee, but Lt James Kelley, the new Air Service representative (he joined Consolidated in 1929).

1 Consair was a frequently used abbreviation as was the more official CAC.

2 Although Galludet has been referred to as the first of the companies leading to the present General Dynamics/Convair corporation ever since the official history *Dynamic America* appeared in 1958, this was not the case. Fleet became general manager of Gallaudet but left to form Consolidated and *only* rented workers and space for a short period from Gallaudet. No Gallaudet-originated designs were adopted or marketed by Consolidated and the Gallaudet company remained in existence, albeit not in aircraft manufacturing, for some time after Consolidated was formed and subsequently moved to Buffalo.

Consolidated's patriotic eagle emblem was retained in modified form by Consolidated Vultee and Convair but disappeared with the absorption of the latter into General Dynamics.

In 1925, the Consolidated trainer won a Navy competition, followed by further orders from the Army, and with refinements the design stayed in production until 1928 when over 800 had been completed. Fleet had gambled on the success of the PT/ NY series by purchasing building materials for the aircraft in quantity in advance of actual contracts. By 1927, Consolidated showed a cumulative profit of $867,000 on Service trainers it had built since 1923 and this led to the famous 'Fifty Planes for Fifty Dollars' incident. Maj-Gen Mason M Patrick, Chief of the Air Corps, asked for Consolidated's audited costs (a privilege not yet granted by law) and followed up with a demand for a $300,000 refund on excess profits. As the money would have disappeared into the US Treasury, Patrick requested that instead, fifty PT-3s (then priced at $6,000 each) be produced at no cost to the Army. Because the Army was the major source of Consolidated's business, Fleet and the directors felt that they had little choice but to accede. However, Fleet called on Patrick personally, with the result that the PT-3s were delivered at a nominal charge of one dollar each.

Rear Admiral Moffett declined to join the Air Corps either in seeking the settlement or accepting its proportion (26 per cent) of the refund, declaring that all procurements had been subjected to competition in accordance with law and that it was not in a position to question a company's profit.

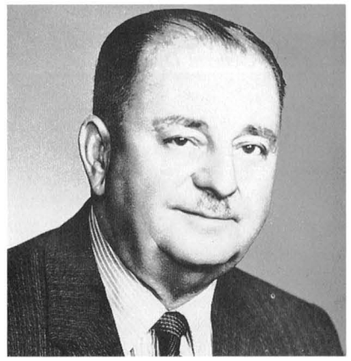
Clark resigned in June 1927 but his position as chief engineer was not filled. Instead, Fleet established divisions at Buffalo with an engineer in charge reporting directly to him. Former Gallaudet engineer Joseph M Gwinn Jr, took charge of Unit 1 (training aircraft) and Fleet established Unit 2 (flying-boats) in 68,000sq ft of additional floor space adjacent to the old Curtiss plant under I M 'Mac' Laddon. Laddon had joined Consolidated in March 1927. He had been with the Engineering Division at McCook since 1917 and when the Army discontinued building prototypes, he turned to the design of ancillary equipment and was awarded patents for aerodynamic, structural, and equipment developments. The Bendix-Laddon disc wheel and integral brake became standard equipment in the late 1920s.

Laddon initially remained at Dayton with a field staff (including C B Carroll, later project engineer on the XFY-1 Pogo) and worked on the Model 11, a heavy twin-engined bomber. This was abandoned when Consolidated and a former competitor, Sikorsky, agreed to collaborate on a design from the latter's drawing-board. When the new bomber rolled out in late 1927 at Sikorsky's Long Island plant, it bore the legend Consolidated Sikorsky Guardian and was flown by Consolidated's test pilot Leigh Wade. After initial tests, Consolidated decided that the aircraft fell short of the Army's specifications and withdrew from the design contest. However, it was too late to cancel press releases and advertisements that described the Guardian as a joint project. The Army contract eventually went to the Curtiss B-2 Condor.

In 1928, Laddon worked on a Navy design competition for a large flying-boat with sufficient range to fly between the West Coast and Hawaii (over 2,000 miles). The result was the XPY-1 Admiral. But although Consolidated won the competition, the production contract for nine aircraft was put up for competitive bidding and went to the Glenn L Martin Company. Years later, Consolidated men said, 'Martin underbid us by half a million dollars and they lost a million on the job.'

But Fleet had already found a buyer for a commercial version of the Navy 'boat and six Commodores were ordered by the New York, Rio &

Developed from the Dayton Wright TW-3, over 800 Consolidated PT-series aircraft were built between 1924 and 1929. (USAAC)



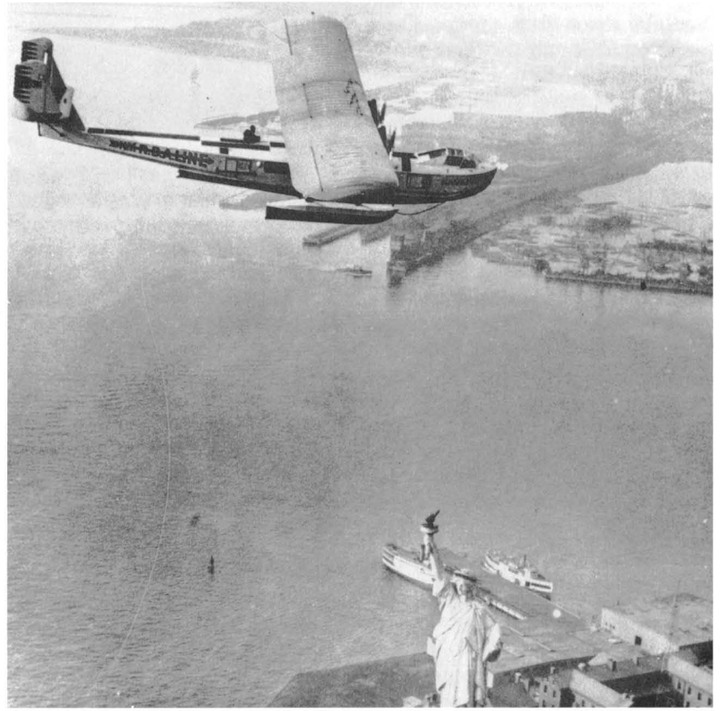
The inventive genius behind Consolidated's designs, Isaac Machlin 'Mac' Laddon. (San Diego Aerospace Museum)

Buenos Aires Line (NYRBA). In actual fact, this company was part-owned by Fleet, together with James H Rand of Remington Rand (who had established NYRBA's immediate predecessor, Tri-Motor Safety Airways) and Ralph O'Neill. O'Neill had been an aviation advisor to the Mexican Army and was fluent in Spanish, and Fleet and Rand financed O'Neill on an exploratory trip through South America. In Buenos Aires, O'Neill negotiated a remarkably favourable contract that exclusively provided the new airline with all Argentine mail destined for North America at $10 a pound. Moving north, a similar contract was signed in Rio de Janeiro. Pan American Airways soon offered to buy out the three partners for $25,000 each, according to Fleet, but they agreed to decline the offer.

Fleet's investment in NYRBA brought a beneficial effect to Consolidated as the airline not only bought fourteen Commodores (at around $100,00 each) but also a launching order for a fast six/seven-seat passenger and mail transport, the Model 17 Fleetster. During 1930, several forces worked together to force the sale of NYRBA to Pan American and on 31 August, Juan Trippe purchased and absorbed his competition in South America.

Fleet also formed several other subsidiary companies. The Tonawanda Products Corporation was formed to manufacture parts for Consolidated in October 1927. The plant, situated close to the Buffalo factory, was headed by Charles T 'Chuck' Leigh, formerly assistant factory manager for Consolidated. Frontier Enterprises Inc was established as a holding company for Tonawanda Products. Frontier also operated Consolidated's airport at Tonawanda and an aerial sightseeing business called Niagara-from-the-Air.

In an effort to produce a low-cost trainer suitable for civil use, Fleet, moving with speed and secrecy, rented a suite of rooms at the Buffalo Athletic Club and locked himself up there with Joseph Gwinn, George Newman, Leigh Wade and Ralph Oversmith, material supervisor of Consolidated. In two and a half days they had finished the design of the Model 14 Husky Junior. First flown in November 1928, the Husky Junior attracted orders but Consolidated's directors were sceptical of its potential. There was doubt that a factory used to building military aircraft could profitably produce civil



The first successful Consolidated flying-boat was the Model 16 Commodore derived from the XPY-1 Admiral. Here, NC659M Havana *of NYRBA circles the Statue of Liberty.* (Convair)

types, $174,000 had already been spent, and there was an unwillingness to include the Husky Junior in Consolidated's product line as the company was about to go public with a stock offering.

Therefore, Fleet personally purchased the rights to the design for the amount spent on development and formed Fleet Aircraft Inc on 22 February, 1929, with Lawrence D 'Larry' Bell as president. A contract for 100 aircraft was given to Consolidated and the aircraft renamed the Fleet. By summer, sales were booming and because of military interest in the type and the conflict of interests with two Fleet-owned manufacturers under one roof, Fleet Aircraft Inc was sold to Consolidated in August. Fleet Aircraft Inc was kept intact as a sales agency, headed by Bell, who became a Consolidated vice-president. Development of the Fleet design, mostly through engine changes, was put in the hands of Unit 3, headed by Joe Gwinn. Maj Fleet also organised National Flying Schools Inc to promote flying training with the Fleet and thus stimulate aircraft sales, and this was run by Consolidated's sales manager, Leigh Wade.

In August, Fleet embarked on a cross-country sales tour of aircraft manufacturers and dealers in a new Fleet 3. During this tour, Fleet met and hired Gordon E Mounce as Pacific Coast representative for the Fleet. Mounce later became Consoli-dated's European agent and was killed at Belgrade after performing twenty-one consecutive outside loops. On 13 September, on the last leg of the nationwide trip from Detroit to Buffalo, the Fleet suffered engine failure over West Lorne, Ontario, and an attempted forced landing ended in a crash. Fleet survived with multiple injuries, but his companion died the next day.

During Fleet's recovery, Larry Bell took over as general manager with Ray Whitman as his assistant. Just before Fleet's accident, the Thomas-Morse Aircraft Corporation of Ithaca had been acquired as a subsidiary of Consolidated and established as Unit 4 at Buffalo. Heading the subsidiary as president was designer B Douglas Thomas.

On 25 March, 1930, another subsidiary, Fleet Aircraft of Canada, Limited, was formed at Fort Erie, Ontario, three miles across the Niagara River from Buffalo. The main reason was the attitude of the US State Department which would only issue a permit for export of an aircraft to a foreign country for 90 days. Therefore, there was uncertainty that a foreign order could be delivered once it had been fulfilled, a problem that did not arise under Canadian laws. A small factory was built on a 100-acre airport at Fort Erie and W J 'Jack' Sanderson, an ex-RCAF pilot who had visited Fleet during his stay in hospital in London, Ontario, after his accident, was made president. At first, parts were supplied by Consolidated for Fleet production,

The Fleet logo.

later the Canadian concern built some 700 Fleets.

The company passed to Canadian ownership on 17 November, 1936, and renamed Fleet Aircraft, Limited. Rights to the Fleet in the United States (along with those to the PT/NY series and O-19) were sold by Consolidated on 6 April, 1939, to the Brewster Aeronautical Corporation, Long Island City, New York, for $25,000 but no further production took place.

During the first half of the 1930s, Consolidated's fortunes were similar to other US manufacturers, abundant developments and ideas but few profits. In 1930, Consolidated delivered 309 aircraft for $4,345,170 (more than any other individual company in the USA). However, the net profit for the year was just 3 per cent of sales, far too low to cover the vagaries of aircraft manufacturing. Production dropped by two thirds in 1931, and to less than 100 aircraft the following year. But in 1933, export orders for Fleet trainers and deliveries of a new twin-engined Navy flying-boat, the P2Y Ranger, improved the company's outlook. Designed by Laddon, the P2Y (Model 22) was a sesquiplane version of the Admiral/ Commodore series. Long-range formation delivery and transfer flights with the P2Y, started by VP-5 and VP-10 in late 1933, resulted in much favourable publicity for Consolidated.

In late 1931, Consolidated took over the YP-24 design from Detroit Aircraft (together with its designer, Robert J Woods) and had its first, and last, fighter experience. Production of the P-25/P-30 series was slow and costly, because it was only the company's second attempt at working with all-metal wings. The first had been the Model 18 Fleetster (XBY-1) for the Navy. In 1933, following work on the Model 24 (XB2Y-1) for the Navy, B Douglas Thomas retired from Consolidated and the Thomas-Morse subsidiary ceased to be an active part of Consolidated.

Fleet had begun to think about an alternative manufacturing site to Buffalo in 1929, as the harsh New York winters made flying-boat testing impossible. The other requirements were a public airport, seaplane facilities, and an adequate labour supply. Although Long Beach was considered, all the needs were satisfied at San Diego which, in addition, had the added advantage of being the home-port for the Navy's Pacific Fleet with a naval air station already established at North Island. On the day of Consolidated's tenth birthday, 29 May, 1933, a decision was made by the board of directors to move to San Diego. Subsequently, a lease was signed for land adjoining San Diego's Lindbergh Field airport and the harbour. In 1934, architect L B Norman was retained to draw up plans for a modern 'continuous plant' on the site, and early the next year, work began on the building.

Consolidated's move to San Diego from Buffalo was the furthest made by a major manufacturer up to then. The transfer was further complicated by an order for fifty P-30As (PB-2As) placed by the Army in December 1934, and for a $6.5 million order for sixty PBY-1s received in late June 1935 from the Navy. Work continued at Buffalo until 16 August, 1935, then resumed at San Diego (with the PB-2A) after the Labor Day weekend on 3 September. A total of 157 railway freight cars, (including 21 full of household goods) took Consolidated across the country. The move was paid for 300 key employees and 100 others made their own

Aerial view looking west of Consolidated's San Diego plant at Lindbergh Field in early 1939. Two years later, two buildings had been added to the east, and another to the north of the main factory shown here. (San Diego Aerospace Museum)

The progenitor of the Catalina, the most famous flying-boat of all, the XP3Y-1 flies past NAS North Island, San Diego. The site of Lindbergh Field is in the foreground. (Convair)

way to southern California with the promise of jobs at the new 247,000sq ft factory. On 20 October, 1935, the new home of Consolidated was formally dedicated with a public ceremony and open house. A week before, the XP3Y-1 had flown nonstop from Coco Solo, Canal Zone, to San Francisco (3,443 miles) in 34hr 45min, a new record for seaplanes. The aircraft and its crew, under the command of Lt-Cdr Knefler McGinnis, formed the centrepiece of the festivities.

Larry Bell did not move, but resigned to form his own company, and was joined by Ray Whitman and Robert Woods who became vice-president and chief designer respectively. Bell took over the former Consolidated plant together with many of Consolidated's former employees, and one of its first contracts was to build outer wing panels for the PBY-1s.

Following the move to San Diego, Fleet appointed three new vice-presidents: Laddon as chief engineer, Chuck Leigh as materials supervisor, and Charles A Van Dusen, formerly with Glenn Martin, as works manager. A second order for sixty PBYs came in July 1936, followed by a third in October. In May, Consolidated had been declared winner of a design competition for a much larger, four-engined flying-boat, the XPB2Y-1, which, because of security reasons, had to be built in a separate building away from the main production line. In order to cope, the factory was enlarged to 450,000sq ft and an additional 170,000sq ft area was paved where overflow final assembly operations could be made in the almost guaranteed sunshine. Profits began to rise and by 1937, the payroll had climbed to 3,700 and Consolidated had gained the status of a major industrial enterprise.

However, towards the end of the following year the PBY contracts had largely been fulfilled and employment dropped to 1,200. In December 1938, at the suggestion of the Army Air Corps, Laddon and Van Dusen visited Seattle for talks with Boeing concerning licence production of the Boeing B-17. No agreement was made and they came away certain that a superior bomber could be built by Consolidated much easier and faster. In January, the preliminary design of the Model 32 was offered to the Army Air Corps; by the end of the month a mock-up had been completed; three weeks later a prototype XB-24 was ordered. The swift pace of events was spurred by President Franklin .D Roosevelt's call for an appropriation of $300 million for new aircraft, approved by Congress in April. Five months later, all speculation about what the future held was cast aside. Europe was at war.

On 12 September, 1939, the Army ordered seventy-six B-24D Liberators from Consolidated. The Navy followed on 20 December with an order for one hundred and sixty-seven

PBY-5s. The massive procurement for the Second World War was under way. An additional 411,000sq ft of factory space was added at San Diego, the cost borne by the Government under an Emergency Plant Facilities contract. Another expansion programme was initiated in spring 1940, augmenting Consolidated's space by almost 646,000sq ft. On 16 November, a contract was signed with the Defense Plant Corporation and work started on Plant 2, one mile north of the original site and connected to it by an overpass crossing Pacific Highway. The new parts facility consisted of three main buildings, each 750ft long and 450ft wide for a total of 1.5 million sq ft. To accommodate the influx of workers from all over the country, government-sponsored public housing projects around San Diego were speedily approved. Plant 2 was dedicated on 20 October, 1941, by which time employment had risen to 24,000. In comparison, the figure had stood at 3,170 early in 1940. By the end of 1941, the total had escalated to 33,000 and reached 45,000 by the following summer.

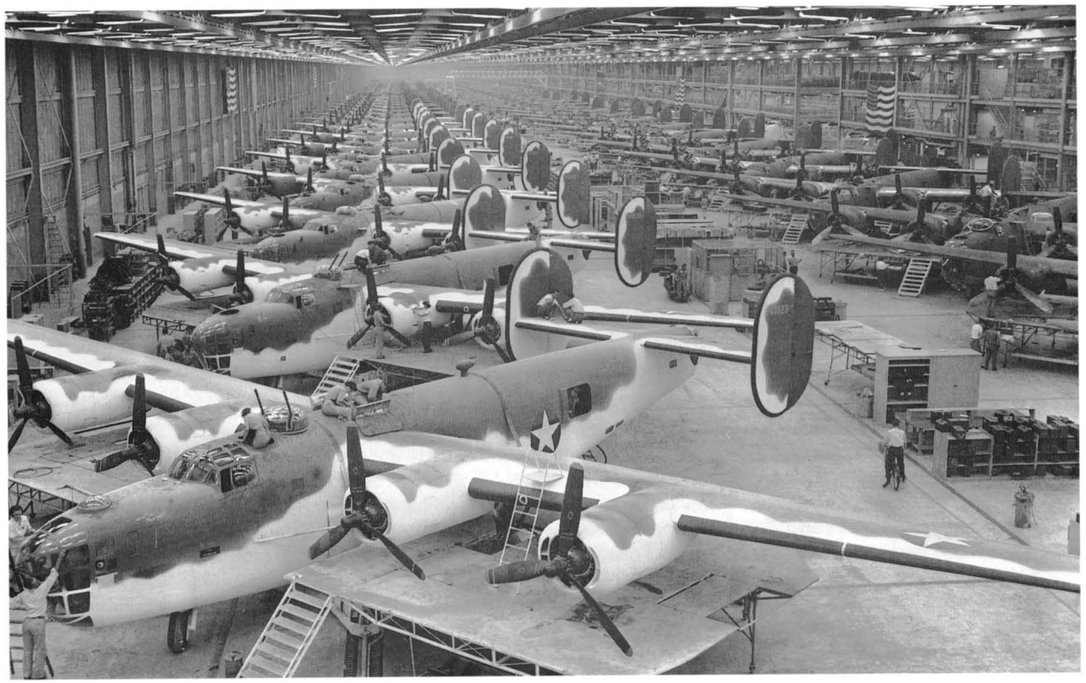
Fleet also assisted Fred H Rohr, previously factory manager at another San Diego-based manufacturer, the Ryan Aeronautical Corporation, to start his own business. The Rohr Aircraft Corporation was established at Chula Vista, at the southern end of San Diego harbour, and became a major subcontractor for Consolidated.

In late 1940, the War Department decided that production of the B-24 would be pooled by Consolidated with three new large plants, all situated inland secure from possible enemy attack. The three sites chosen were Willow Run, near Detroit, Michigan, for operation by the Ford Motor Company; Tulsa, Oklahoma, for Douglas; and Fort Worth, Texas, for Consolidated. Subsequently, the plan was modified in that Ford would initially produce parts and sub-assemblies rather than complete aircraft and later, another plant for North American was completed at Dallas, Texas.

Fort Worth was apparently chosen because of promises made by Roosevelt to local politicians, as there was not a pool of labour already available in non-industrial Texas. Originally designated the Fort Worth Aircraft Assembly Plant, the 438-acre site adjoined the Fort Worth Army Air Field and ground was broken on 18 April, 1941. The plant was designed and built by the Austin Company and featured a 4,000ft long assembly building with an area of almost 2 million sq ft and a 200ft-wide clear span production bay. A parts plant addition a year later added 840,000sq ft. By July 1941, Consolidated had assembled a nucleus of 1,000 engineers who were sent to San Diego for training but the experienced engineering staff in California was halved with the new facility, a measure that caused manpower shortages throughout the war. Mainly

Fleet's slogan, 'Nothing Short of Right is Right', being painted in 9ft letters on the side of the San Diego plant facing Pacific Highway in May 1941. The 480 ft long sign was painted over when the factory was camouflaged. (San Diego Aerospace Museum)

The 5,000th Liberator, B-24J-195-CO 44-41064 V GRAN D, *was inscribed with the signatures and graffiti of hundreds of San Diego workers. (Convair)*



The mile-long assembly line at Fort Worth. The first nine Liberators are San Diego-built B-24Ds under conversion to Navy PB4Y-1s. The others are Fort Worth-assembled B-24Ds. (Convair)

Last great design from Consolidated, the XB-36 cruises over Convair's Fort Worth plant. (General Dynamics)

as a means to acquire more engineers, Consolidated purchased the Hall-Aluminum Aircraft Corporation in August 1940. As the Ford factory was not yet in production, when Fort Worth started work in May 1942, it assembled B-24s from San Diego-built components.

In 1941, the 54-year-old Fleet decided to sell his and his family's considerable holdings of Consolidated stock. The main reason he put forward was intolerable taxation with the result that he retained just one per cent of his salary. However, there was also a sense of frustration as, with numerous government agencies directing the massive industrial expansion of Consolidated, he could no longer exercise his hitherto legendary 'one man control'. Exacerbating this situation were a number of labour disputes. Despite urging from military authorities to divest, Fleet still held Consolidated's top three positions, chairman, president, and general manager. Because his stock, over one-third of the company, would give any purchaser control, and considering Consolidated was a major manufacturer for both the Army and Navy, there was a careful search for the right buyer.

By July, a Washington-sponsored proposal had emerged for a holding company, the Aviation Corporation (AVCO), headed by financier Victor Emanuel, to acquire Consolidated through a small subsidiary, Vultee Aircraft Inc of Downey, California. A survey made by AVCO in August caused Emanuel to withdraw his offer, but the takeover was revived in October. On 25 November, 1941, ten days after Consolidated had received a contract for another bomber, the six-engined XB-36, the largest merger in US aviation history was announced. Vultee would purchase the 440,000 shares of Consolidated common stock held or controlled by Maj Reuben Fleet for $10,945,000. The contract signing was toasted by Fleet and Vultee president Richard W Millar with Coca-Cola in paper cups. Emanuel declined the beverage. On 19 December, the transfer of stock was effected and the AVCO-Vultee management, headed by Tom M Girdler, took over Consolidated. Harry Woodhead, previously president of AVCO and board chairman of Vultee became president of Consolidated. Mac Laddon remained at San Diego as vice-president and general manager. Chuck Leigh also stayed at San Diego along with the founder's son, David G Fleet, although the latter moved to Downey as general manager of Vultee. At the Fort Worth division, George Newman remained as vice-president. Reuben Fleet did not make a complete break form Consolidated as he served as a consultant until the end of the war.

In March 1942, Millar resigned from Vultee and the position of president of the two companies was assumed by Harry Woodhead. Work then started on the mechanics of a complete merger. On 17 March, 1943, stockholders approved the plan which became effective the following day.

Fleet's company survived the amalgamation and the corporation was henceforth known as Consolidated Vultee Aircraft. Girdler and Woodhead retained their positions and Laddon became an executive vice-president. In June, the company's internal newspaper, the *Consolidator*, mentioned the abbreviation Convair for the first time, a term that gradually came into widespread use, although not made official until 1954.

Fleet remained in San Diego and concentrated on his many business activities and civic work for the city. One of his most well-known legacies is the Reuben H Fleet Space Theater and Science Center, located in Balboa Park next to the San Diego Aerospace Museum. In the latter building, Maj Fleet is enshrined in the International Aerospace Hall of Fame. Vigorous, forthright, and outspoken to the end, Fleet lived his motto 'nothing short of right is right' every day. He died in San Diego on 29 October, 1975, at the age of 88.

Consolidated Models and Production Summary

	Model Type	*Number built*
-	TW-3 (Dayton Wright)[1]	20
-	TW-5 (Huff-Daland)[2]	1
1	PT-1 'Trusty'[3]	224
2	NY-1/NY-2/PT-3 'Husky'/O-17 (USAAC)	591
3	Design for Navy competition	0
4	Biplane design	0
5	Monoplane design (Wright J-5)	0
6	Monoplane design for Army	0
7	O-17 Courier, RCAF landplane	2
8	O-17 Courier, RCAF seaplane	1
9	XPY-1 Admiral	1
10	Civil cabin monoplane	1
11	Twin-engined bomber design	0
12	Commercial PT-3 variant[4]	0
13	Believed not used	
14	Husky Junior/Fleet 1-16[5]	614
15	Wasp-powered commercial Courier	1
16	Commodore	14
17	Fleetster	14
18	Fleetster (XBY-1)[6]	1
19	Untraced design study/ not built	0
20	Fleetster	11
21	PT-11/PT-12/BT-7 series, N4Y[5]	66
22	P2Y-2/3 Ranger[7]	55
23	XO-932 (Thomas Morse)	1
24	XB2Y-1	1
25	P-25	1
26	P-30[8]	30
27	A-11	5
28	XP3Y/PBY Catalina series[9]	3,281
29	PB2Y Coronado	207
30	PB3Y	0
31	P4Y Corregidor	1
32	B-24 Liberator[10]	18,482
33	XB-32	3
34	B-32 Dominator/ Terminator[11]	115
35	Tandem tractor/pusher design	0
36	B-36 'Peacemaker'[12]	383
37	XC-99	1
38	Model 31 wing with B-24D fuselage	0
39	Liberator-Liner (changed to Convair 104)[13]	2
40	P4Y-2 Privateer and RY-3 (changed to Convair 100 and Convair 101)[13]	774
	Total	24,904

The total by location is as follows: Consolidated, Gallaudet factory, Rhode Island, 21; Consolidated, Buffalo, 1,594; Consolidated, San Diego, 9,915; Consolidated, Fort Worth, 3,531; Consolidated, New Orleans, 235; Naval Aircraft Factory. Philadelphia, 155; Boeing Aircraft of Canada, Vancouver, 362; Canadian Vickers/Canadair, Montreal, 369; Douglas, Tulsa, 964; Ford, Willow Run, 6,792; North American, Dallas, 966. Although exact figures are not available, production of Consolidated designs by Fleet Aircraft of Canada Ltd (approx 700), Societate Anonima Industria Aeronautica Romana (I.A.R.) and Fabrica de Avione S.E.T. in Romania, and in the Soviet Union, brings the total to over 26,000 aircraft.

Notes:

1 Built at Gallaudet factory at Rhode Island. The order covered an additional three spare airframes.

2 Serial 25-245 The prototype PT-1 was unofficially designated TW-8 and may have been the 'Camel', thus a converted TW-3, and is not included in this figure.

4 There is no confirmation that a civil PT-3 was built.

5 Buffalo production only. Canadian production was around 680 Model 14s and eleven Model 21s. In addition, over 300 Model 14s were built under licence in Romania.

6 Plus one static test airframe.

7 Six P2Y-3As built at San Diego.

8 First San Diego-built aircraft.

9 Includes all production as follows:

Consolidated (Buffalo)	1
Consolidated (San Diego)	2,159
Consolidated (New Orleans)	235
Naval Aircraft Factory (Philadelphia)	155
Boeing Aircraft of Canada (Vancouver)	362
Canadian Vickers/Canadair (Montreal)	369

Soviet production not included, estimated at 150 pre-October 1941.

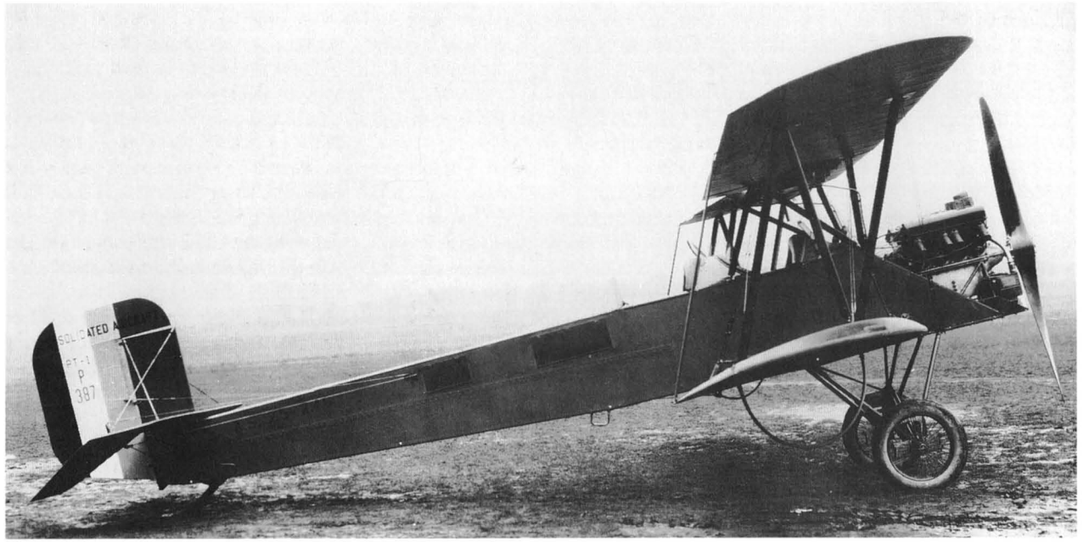
10 Figure includes all production, breakdown as follows:

Consolidated (San Diego)	6,726
Consolidated (Fort Worth)	3,034
Douglas (Tulsa)	964
Ford (Willow Run)	6,792
North American (Dallas)	966

11 All but one built at Fort Worth

12 Fort Worth production after merger with Vultee.

13 San Diego production after merger with Vultee.



The second PT-1, 25-246/P-387 with flat-top fuselage, at McCook Field. (McCook Field)

Consolidated Aircraft

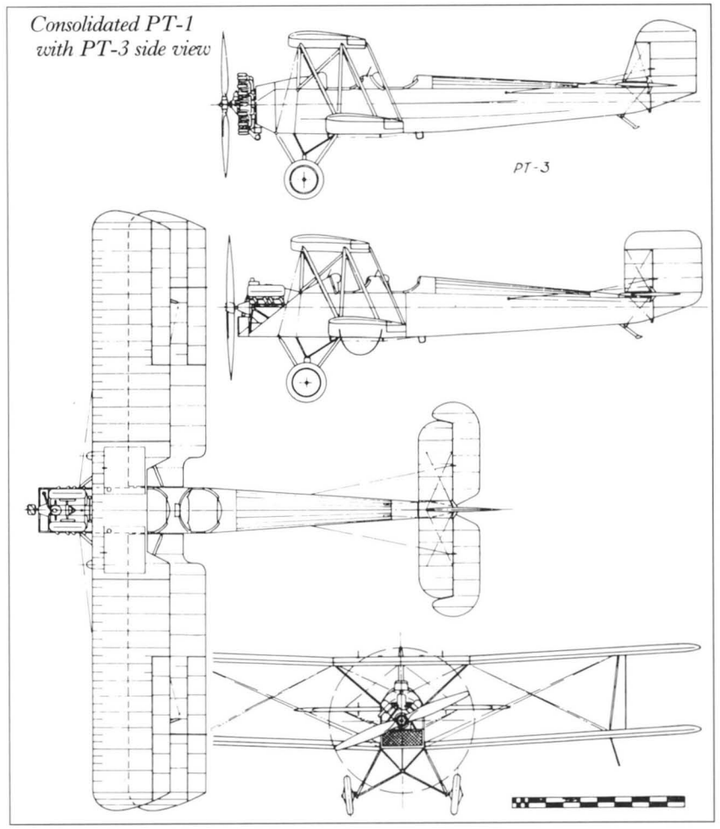
Model 1/2/7/8/12/15 PT/NY Series (Trusty, Husky and Courier)

Reuben Fleet worked closely with the Army to improve the Dayton Wright TW-3 and thus was in a competitive position when a contest for a new primary trainer was announced in 1924. Fleet had earlier modified a TW-3 into the Camel, an unofficial name for the tandem-seat version. The other major features of the TW-3, the 180hp Wright E engine, spruce-spar wings—the upper centre section containing two 20US gal fuel tanks—and steel-tube fuselage, tail group, interplane struts, and split-axle undercarriage (fitted with DH-4 wheels), were retained. Consolidated's prototype (reportedly 23-1253), and unofficially designated TW-8, achieved success in the Army competition held at Brooks Field, San Antonio, Texas, (home of the Air Service's primary training school) during early summer 1924. An initial order for fifty trainers, designated PT-1, was placed at a cost of $9,800 each.

All production PT-1s were built at Buffalo although some fabrication appears to have been accomplished at the Gallaudet factory in July 1924 before the company's move two months later. The first batch of the fifty (25-245/294) were delivered in increments of ten with modifications incorporated at Consolidated's expense until the Army decided no more were necessary from number 34. Three more orders (26-226/275, 26-301/350, 27-108/177) were subsequently placed bringing the total production to 220 plus the prototype. The latter may have been the aircraft called the Camel and also, later on, the XPT-1, a designation used after PT-1 production had started to distinguish one aircraft with a different cowling to improve cooling characteristics. However, this was not successful and for this reason, plus weight and cost reductions, all PT-1s were delivered uncowled. The PT-1 soon became known as the 'Trusty', because the 24in wing stagger resulted in excellent spin recovery behaviour. During the first year of service at Brooks Field, the PT-1 trained 531 students without a serious injury, a significant achievement compared to the record of the Curtiss' JN-4 it replaced.

Six PT-1s, 25-245/P-386, 25-246/P-387 (with flat top fuselage decking), 25-264//P-396, 25-292/P-570, 26-327/P-454, and one unidentified (P-422), were tested at McCook Field, one (27-176) was diverted to the Navy, and four others were built for Siam (now Thailand) in 1928. Replaced by the PT-3 by 1928, the Army survivors were transferred to National Guard units until withdrawn three or four years later. A civil Approved Type Certificate (ATC 79) was awarded in November 1928 but this was retroactive.

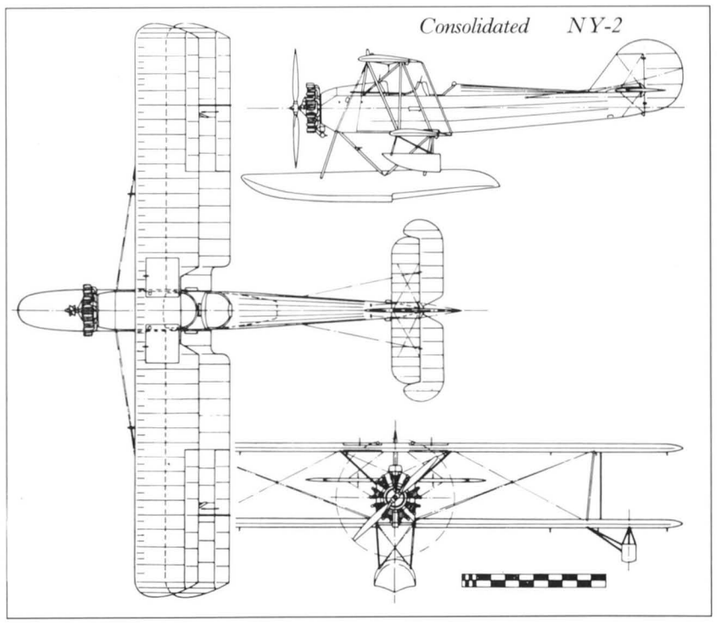
In 1925, the PT-1 had won against fourteen other proposals in the Navy's trainer competition. The Navy specified the 200hp Wright J-4 (R-790) Whirlwind air-cooled radial, designed by Charles L Lawrance of the Wright Aeronautical Corporation, for its Model 2 NY-1s. Provision was also made for the wheeled undercarriage to be replaced by a single large float with wingtip stabilising floats. A larger-area vertical fin and rudder was also fitted. Other change included the replacement of zinc plating with cadmium to prevent salt water corrosion. The initial contract for forty (BuA-7163/7202) was followed by thirty-six more (BuA-7205/7220, A-7351/7360, A-8173/8182). The first flight was made on 12 November, 1925, by Lt Carl A Covey (USAAS) from Logan Field, St Helena, Maryland, and the same day Fleet and Clark delivered it to NAS Anacostia for acceptance trials. Converted to a seaplane, it was



wrecked when it landed short of the water. Production examples were shipped to NAS Pensacola, Florida, in May.

The designation NY-1A was applied to aircraft fitted with a 0.30in gun on a dorsal mounting for use as gunnery trainers and some were later converted to NY-2 standard as NY-1Bs. The unofficial name of 'Husky' was used for the radial-engined versions and again retroactively, ATC 80 was awarded to the NY-1 series in November 1928.

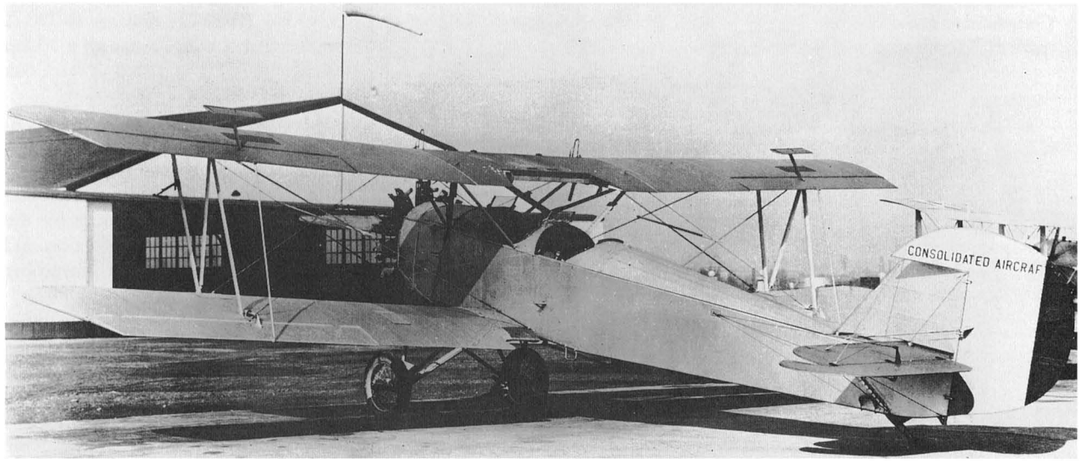
In October 1926, 40ft span wings were built to improve wing loading and these, with the more powerful 220hp Wright J-5 (R-790-8) were fitted to one hundred and eighty-one NY-2s (A-7456/7525, A-7693/A-7707, A-7764/ A-7795, A-7970/A-7977, A-8013/ A-8017, A-8183/A-8192, A-8360/ A-8400). One of these was transferred to the Army (27-176/ P-471) for tests. An additional twenty-five NY-2A gunnery trainers (A-8158/8172, A-8401/8410) and twenty NY-3s (A-8487/8506) with 240hp Wright R-790-94 engines mostly for Navy and Marine reserve squadrons were delivered starting 1929. The sole XN3Y-1 (A-8273) had an R-790-A engine and one XNY-2 with a 300hp Wright R-975 was tested at McCook Field as P-589.



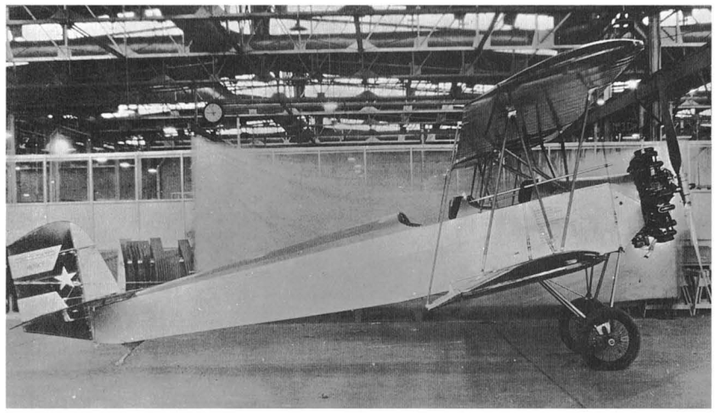
Over one hundred NY-2/3s were in active service in 1929, with thirty-five more assigned to reserve units and fifteen remained in 1937, with one still active in 1939. One was built for the USAAC (30-421) for evaluation and the type given ATC 81 in November 1928.

Because of its stable flying qualities, an NY-2 (NX7918) was used by Lt James H Doolittle for the first demonstration of 'blind-flying' at Mitchel Field, Long Island, on 24 September, 1929. The historic flight was made under a hooded cockpit with safety pilot Lt Ben Kelsey; earlier Doolittle had flown solo in heavy fog but not under the hood.

As supplies of the unwieldy Wright E began to diminish, the Army looked to the air-cooled engine for its next trainer as the Navy had done. To test the installation of the Wright J-5, one PT-1 (27-149/P-469) was completed as the XPT-2 in 1927, followed by the XPT-3 (ex-PT-1 27-177/P-470), also known as the XP-470, which had new wing panels and a revised vertical fin. In this form, 130 production PT-3s (28-218/P-501, 28-219/228; 28-230/316; 28-318/347) were built from September 1927. Four PT-3s were



The NY-2 was operated on wheels and floats. (A R Krieger collection)



One of four PT-3 Huskys delivered to Cuba in 1928. (Sydney H Bradd collection)

Model 7 Courier for the RCAF, with ring gun mounting for the observer. (Murray Ronald)

delivered to Cuba in 1928, plus one each to Brazil, Peru, and Argentina, following a tour in 1929 by Lt Leigh Wade, Consolidated's sales manager. A small number may also have been used in Mexico.

The PT-3A had minor equipment changes and the 225hp R-790-3, one hundred and twenty (29-38/157) were begun in May 1928, fifty of which were sold to the Army for just one dollar each after Maj-Gen Mason M Patrick, the Chief of Air Corps, objected to Consolidated's profits on the sale of trainers. The first (29-38) was tested as P-527, and another (29-115/P-564) was fitted with a 235hp R-790B. The Model 12 was a commercial variant (ATC 83, November 1928) but none appear to have been built for purely civil purposes.

A parallel development was the O-17 Courier, the prototype XO-17 converted from a PT-3 (28-229) flown at McCook Field (as P-510) in April 1927, in a competition to meet an Army specification for a new advanced trainer for gunnery, photographic and radio training as well as cross-country flying. Generally similar to the PT-3 with a 225hp R-790-1, the O-17 had improved fuselage streamlining, oleo shock absorbers, wheel brakes, balanced elevators, and increased fuel capacity. A removable fairing for the rear cockpit enable a Scarff ring to be fitted for a 0.30in gun.

Most of the 29 production O-17s (28-360/385, 28-396/397, 30-89) built from May 1928 went to National Guard units. In July 1928, following a demonstration by Fleet, three were sold to the Royal Canadian Air Force. Two were Model 7 landplanes (RCAF 25 and 26) and one (RCAF 24) a Model 8 single-float seaplane. At the request of Consolidated, ATC 82 was awarded in November 1928 which also covered the sole XO-17A (NC1558), a converted PT-3 (28-317/P-513) with a R-790-3 (J-5C), intended as a demonstrator for export Couriers. The Model 15 Courier was a Pratt & Whitney Wasp-powered experimental commercial variant but only a prototype was completed.

Several designations covered re-engined versions. The XPT-4 (ex-PT-3 28-293/P-528 had an experimental 125hp Fairchild-Caminez 447C engine, the XPT-5 (27-177/P-530) was the XPT-3 fitted with a 75hp Curtiss Challenger R-600-1 two-row six-cylinder radial, but was soon converted to PT-3 standard, the XPT-8 was the XO-17A Courier fitted with a 220hp Packard DR-980 diesel radial, and the XPT-8A a similarly re-engined PT-3A.

Described by Fleet as the 'best, strongest, flying-est trainer in the world', the PT-1/3 series met all the Army's original requirements: extreme robustness, durability of construction , simple and quick maintenance, and the ability to land in a small field. Eventually they were replaced by the Stearman PT-13 although thirty-four PT-3s were still in use at the Spartan school, Tulsa, Oklahoma, during the Second World War.

Of the at least 819 built, only two of the series have survived to become museum pieces, PT-1 27-150 (owned by Harry Kirk 1949-78) is at San Diego and PT-1 26-233 (flown by Paul Mantz in the film *One Man Mutiny* in 1956) is with the USAF Museum. Unfortunately, the flyable PT-3 28-311/N42J, donated to the San Diego Air Museum in August 1969, was destroyed on 22 February, 1978, in the disastrous fire. However, the Experimental Aircraft Association is in the process of restoring a set of wings, tail group, centre section and fuel tanks from a PT-1 into a flyable aircraft powered by a 220hp Continental, using a fuselage borrowed from the USAF Museum as a pattern frame.

PT-1

One 180hp Wright E water-cooled V-8 engine.

Span 34ft 5½in; length 27ft 9¼in; height 9ft 10in; wing area 284sq ft.

Weight empty 1,805lb; gross weight 2,577lb.

Maximum speed 92mph; cruising speed 79mph; climb 690 ft/min; ceiling 14,000ft; range 350 mile (40 US gal capacity).

PT-3

One 220hp Wright J-5 Whirlwind (R-790) nine-cylinder air-cooled radial engine.

Span 34ft 5½in; length 27ft 8½in; height 9ft 10in; wing area 295sq ft.

Weight empty 1,670lb; gross weight 2,447lb.

Maximum speed 105mph; cruising speed 85mph; climb 765ft/min; 5,000ft/7.6min; service ceiling 15,900ft; endurance 3.7hr (250 miles).

NY-2 (Seaplane)

Span: 40ft 0in; length 31ft 4½in; height 9ft 1 lin; wing area 370sq ft.

Weight empty 2,145lb; gross weight 2,843lb.

Maximum speed 90mph at sea level; cruising speed 75mph; climb 630ft/min; 5,000ft/7.8min; service ceiling 11,000ft; range 210 miles.

O-17 Courier

Span 34ft 5½in; length 27ft 11in; height 9ft 9in; wing area 296sq ft.

Weight empty 1,881lb; gross weight 2,723lb.

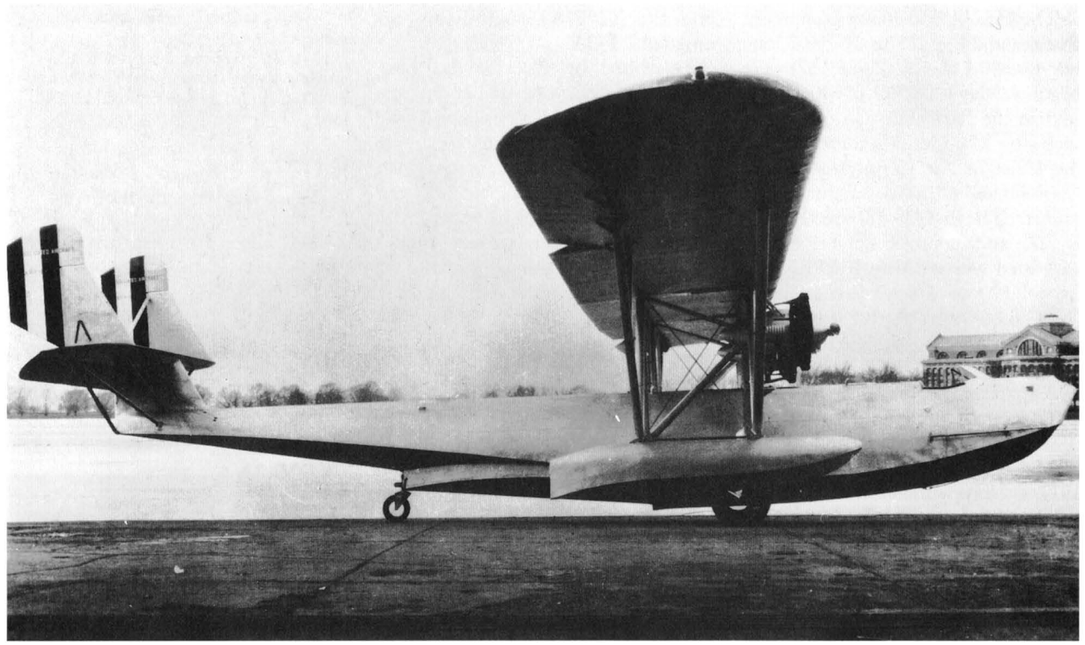
Maximum speed 118mph; cruising speed 100mph; climb 865ft/min; service ceiling 12,000ft; range 350-550 miles.

Model 9 Admiral (XPY-1)

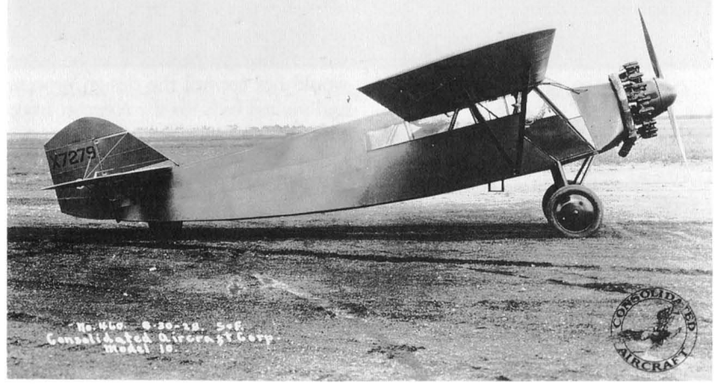
In late 1927, the US Navy was working on preliminary studies for a new long-range patrol bomber, capable of flying nonstop from the West Coast to Hawaii at 110mph. In order to achieve this performance, the design formula called for a 100ft span monoplane of all-metal construction powered by the latest air-cooled radial engines. The hull lines were drawn by Capt Holden C Richardson of the Bureau of Aeronautics, a leading authority on the subject of flying-boats who had supervised construction of the NC boats at Curtiss, but for the first time the Navy would not control the design process and invited bids for the contract from manufacturers.

Laddon (who had designed the hull of the PB-1 for Boeing) and Roy Miller moved from Dayton to Consolidated's Buffalo plant, and using the Navy's general specification and hull design, won the competition for a prototype, designated XPY-1, on 28 February, 1928. Fleet decided to name the aircraft Admiral, in recognition of Admiral Moffett.

The XPY-1 carried a crew of five. The two pilots sat side-by-side in an open cockpit in the bow, the navigator/bombadier in a second open cockpit in the forward bow, armed with a single 0.30in machine-gun, a radio operator in a central compartment, and a mechanic/gunner astern in an open cockpit with twin 0.30in guns. The two 425hp Pratt & Whitney Wasps were strut-mounted between the hull and the semi-cantilever parasol wing, the centre section of which was designed



The XPY-1 Admiral in its original twin-engined form. (Convair)



The sole Model 10,X7279, (Wright J-5 Whirlwind) (Peter M Bowers collection)

to carry a third engine if necessary. The wing aerofoil was Göttingen 398 and the complete aluminium framework fabric covered, with fuel tanks in the centre section and oil tanks in the engine nacelles. To provide stability on the water there were two Richardson-designed floats attached by a multitude of aluminium alloy or steel tube struts to wings and hull, the latter built up of duralumin covered with aluminium sheet. The tail group was also fabric-covered and consisted of a stub fin carrying twin fins and rudders.

Construction started in January 1928 at the Elmwood Avenue Plant 2, Buffalo, and was complete by December. However, as both the Niagara River and Lake Erie were frozen over, the 'largest flying-boat in the USA' had to be loaded onto three railway flat cars and taken to NAS Anacostia, DC, for assembly. On 10 January, 1929, the XPY-1 (BuA-8011) made its first flight in the hands of Lt A W Gorton with Laddon aboard. As Edward P Warner, Assistant Secretary of the Navy for Air, insisted on a maximum speed of 135 mph, a third engine was subsequently installed. However, as a trimotor, the XPY-1 was impossible to hangar and servicing at sea was highly dangerous. A contract for nine aircraft was put out for competitive bidding in June 1929. In order to recoup its development investment, Consolidated had to add half a million dollars to its bid and the contract went to Martin. However, Martin took 28 months to complete the three-engined XP2M prototype and nine twin-engined P3Ms and undoubtedly lost a considerable sum on the contract.

Two 450hp Pratt & Whitney Wasp R-1340-38 nine-cylinder air-cooled radial engines.

Span 100ft 0in; length 61ft 9in; height 17ft 4in; wing area 1,110sq ft.

Weight empty 8,369lb; maximum gross weight 16,492lb.

Maximum speed 118mph at sea level; cruising speed 110mph; climb 5,000ft/8.3min; service ceiling 15,300ft; maximum range 2,620miles (1,021US gal fuel capacity).

Model 10

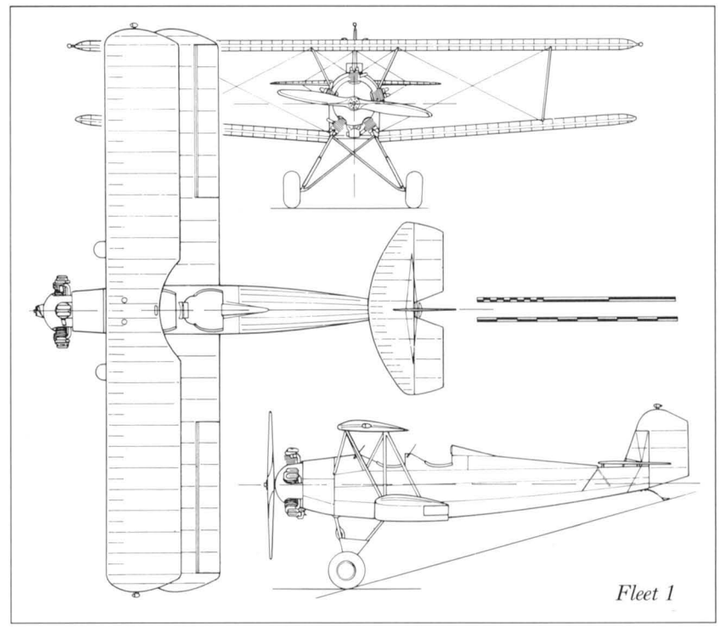
In an attempt to capitalise on the general aviation fever that gripped the United States following Lindbergh's successful Atlantic flight, Joseph M Gwinn Jr designed a six-seat strut-braced high-wing cabin monoplane.

Powered by a 225hp Wright J-5 Whirlwind, the Model 10 possessed two unusual features, a triangular-section fuselage and an overhead control column. The fuselage shape was thought to offer better visibility from the cabin and be less expensive to produce but it was considered ugly by potential customers. Similarly, the simplified control system with single push-pull tubes instead of cables and pulleys was designed to decrease production costs, but was unpopular with pilots even after a stirrup-type grip was installed.

First flown on 10 August, 1928, the prototype (X7279) was subsequently fitted with conventional controls after some near accidents with the unfamiliar control layout. Although flown from Buffalo briefly by Consolidated's own sightseeing company 'Niagara-From-The-Air', no Approved Type Certificate was applied for or further production undertaken. The Model 10 was dismantled then stored for a time in an attic of the Consolidated Military Road hangar at Buffalo.

Span 45ft; wing area 274sq ft.
Gross weight 3,300lb.

Fleet 1 (110hp Warner Scarab) NC8626 (msn 39) on skis. (A R Krieger)



Fleet 1

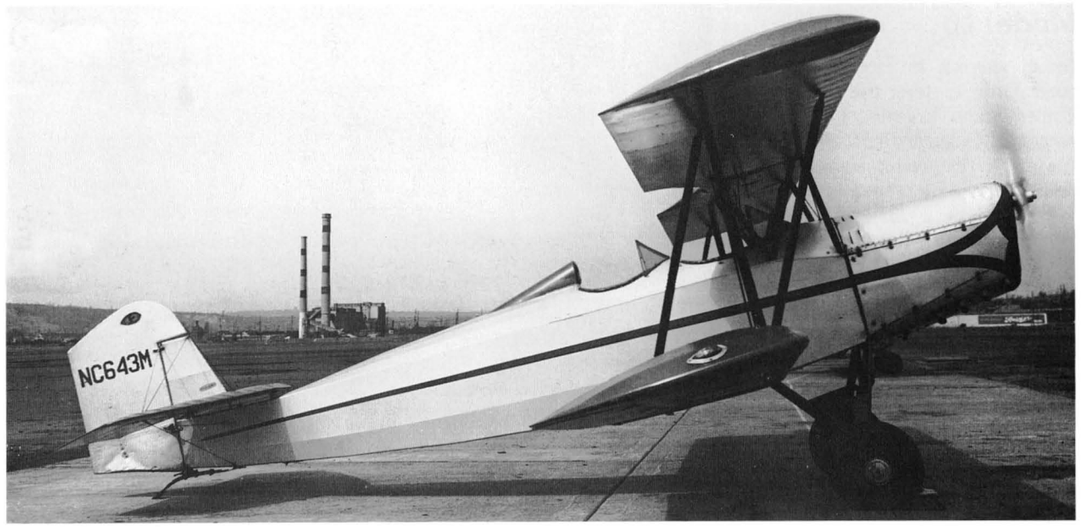
Model 14 Husky Junior and Fleet 1-16

Hoping to repeat the success of the military PT/NY series, Fleet envisaged a scaled-down version weighing less than 1,000lb as a sporting-type trainer for the commercial market. The concept was built around a 110hp Warner Scarab seven-cylinder radial, featured simplicity and ruggedness, and was to be sold at less than $6,000. Early in 1928, the design was finalised in just two and a half days by Fleet, Newman, Gwinn, test pilot Leigh Wade, and material supervisor Ralph Oversmith. Meeting in secrecy at the Buffalo Athletic Club, the lines of the Husky Junior were sketched out (to full scale) in chalk on the carpet of Fleet's suite!

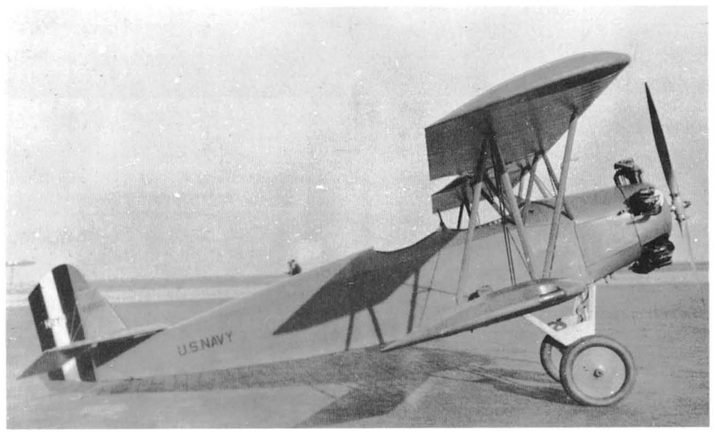
The fuselage and tail unit were constructed of welded chrome-moly steel tubing, fabric covered, with two seats in one elongated open 'bathtub' cockpit. The steel-tube strut-braced staggered wings were of Clark Y-15 aerofoil, with spruce spars and aluminium wing ribs, also covered with fabric which was attached with self-tapping screws with a large washer underneath instead of the more usual stitching. The upper wing was built in a continuous section with a 24US gal capacity fuel tank in the centre. Ailerons were only fitted to the lower panels and the undercarriage was of the cross-axle oleo type. With neutral stability (a first for an approved civilian trainer type) the aircraft proved quick and light on the controls, and fully aerobatic.

Three aircraft were built in 26 days and the prototype (X-86E) first flew on 9 November, 1928. Following testing by Wade and Fleet, the Model 14 was awarded ATC 84 the same month. Flown to the first International Aeronautical Exposition held at Chicago in December, two were sold for $7,500 each and many orders taken.

However, the other Consolidated directors were sceptical of further production being profitable and wished to discontinue the line. But Fleet purchased the rights for himself and



The sole Fleet 1 Special, NC643M (msn 218), with 95hp Menasco Pirate B-4. (Gordon S Williams)



N2Y-1 (Fleet 2) A-8600 (msn 264). (via Terry Judge)

formed Fleet Aircraft Inc in February 1929, and gave a contract for 110 to Consolidated. Six months later the company was sold to Consolidated.

With no more than a dozen Husky Juniors completed, production — which quickly reached two aircraft a day — was switched to the renamed Fleet biplane in the following models.

Fleet 1 (ATC 122, May 1929). Initially retained bathtub cockpit of Husky Junior but later aircraft revised with bucket seats in separate tandem cockpits, protected by small rectangular windshields. The certificate was amended on 29 October, 1929, to include a seaplane version with twin Edo floats. At least eighty-nine civil aircraft were built in 1929-30 including one for export to Brazil, plus one for the Navy for evaluation, designated XN2Y-1 (BuA-8019).

Fleet 1 Special (Group 2-305, 21 November, 1930). One aircraft (msn 218/N643M) modified by Menasco Motors with a 95hp four-cylinder Menasco Pirate B-4 for tests.

Fleet 2 (ATC 131, June 1929). As Fleet 1, but with 90hp (later 110hp) Kinner K-5 five-cylinder engine; at least 203 built in 1929-31 for US, civil market (five subsequently to Argentina) plus sixteen for the Army, six for the Navy, and thirteen for Argentina (R49/R54, R58/R64; the last seven delivered in 1933). The Navy aircraft were designated N2Y-1s (BuA-8600/8605 msns 264/269) and used as 'Skyhook' trainers for pilots assigned to the airships *Akron*, *Los Angeles*, and *Macon*. One (BuA-8602) became the XN2Y-2 seaplane and then, in 1934, the XOZ-1 with the upper wing replaced by a four-bladed autogiro rotor by the Pennsylvania Aircraft Co. Three other aircraft remained in service until March 1934 when they were replaced by Waco XJW-1s. In 1930, one XPT-6 (30-88 msn 158) was followed by ten similar YPT-6s (30-372/381) and five YPT-6 As, later designated PT-6A (30-382/386) with slightly enlarged cockpits and revised cowling design. Up to ten US-built airframes are thought to have been transferred to a manufacturing subsidiary, Fleet Aircraft of Canada, Ltd (renamed Fleet Aircraft Ltd in 1936); established at neighbouring Fort Erie, Ontario, on 25 March, 1930, but only a few were completed as Fleet 2s before production switched to the Fleet 7. The first Canadian example flew on 27 June, 1930 (CF-ANL msn 315).

Fleet 3 (Group 2-112, 23 August, 1929). As Fleet 1 with 150hp Wright J-6 Whirlwind five-cylinder engine and gross weight of 2,000lb. Two aircraft only and one (msn 24/ NX8612) used by Reuben Fleet on a nationwide sales tour in 1929. On 13 September, the Fleet suffered an engine failure and

the aircraft stalled and crashed in an attempted forced-landing on a farm at West Lorne, Ontario, on the return flight to Buffalo from Detroit. Fleet's passenger was killed.

Fleet 4 (No ATC). One aircraft (msn 23/NC8611) was registered as a Fleet 3 but fitted with a 170hp Curtiss Challenger engine and first flown 13 May, 1929, by Leigh Wade. Sold in July to George M Pynchon, Jr, and used in All-American Air Races, Miami, in January 1931. The aircraft remained as a Fleet 3 on the register and crashed at Bartow, Florida, on 15 January, 1931.

Fleet 5 (Group 2-152, 15 November, 1929). One (msn 206/NC630M) with a 90hp Brownback C-400 Tiger six-cylinder engine and gross weight of 1,620lb. Production plans not proceeded with. This designation was reused for a Kinner K-5 version of the Fleet 10 (instead of the earlier Fleet 2), sometimes referred to as the F5 (F = faired, ie the triangular fin) by Consolidated. Six were built for China in 1934. plus further production in Canada (designated 10A). No type certificate was awarded and they are presumed to have been built under ATC 374.

Fleet 6 (No ATC). One aircraft used for tests with a 165hp Continental A-70 seven-cylinder radial engine.

Fleet 7 (ATC 374, 4 October, 1930). This designation was originally applied to a 11 5hp Axelson B seven -cylinder radial-powered version but the ATC was awarded to a refined

Fleet 7 (Kinner B-5) NC684M (msn 234) with revised fin. (Pete Sarkus)

model with larger plastic windshields and a 125hp Kinner B-5. Early B-5s had an exhaust collector ring around the front of the crankcase, while later versions had a rear exhaust and improved finning and cooling. The 7-C had a coupé-type canopy that weighed 30lb and required additional fin area and was offered with an optional 25US gal belly tank to increase fuel capacity to 49US gal. The latter feature was standard on the 7-Deluxe model. Some forty-eight Fleet 7s were built at Buffalo, including one each for Argentina and Brazil (msn 440/R235 and msn 410 respectively) and many Fleet 1/2s were converted to this standard. Two (msn 212/NC637M and msn 403/NC64VA) were converted to Phillips-Fleet 7 with a 120hp Martin-Phillips 333 inline inverted engine by Phillips Aviation Co (Group 2-562, 10 March, 1942) with a gross weight of 1,678lb. Several US-built Fleet 2s were converted by Fleet Aircraft of Canada to Fleet 7s with a larger fin and this model was built for the RCAF as the Fawn 1. Other Canadian designations (standardized in late 1937) were 7A (Kinner K-5, not built), 7B(Kinner B-5), 7C (Armstrong Siddeley Civet, RCAF Fawn II), 7E (125hp Warner Scarab, not built), 7F (145hp Warner Super Scarab, not built), and 7G (de Havilland Gipsy III).

Fleet Sport 8 (ATC 428, 18 June, 1931). Three-seater (two in front cockpit) engineered by Joe Gwinn with 125hp Kinner B-5 and larger fin and restricted to 25US gal fuel when fully

Three-seat Fleet Sport 8 NC941V (msn 801). (A R Krieger)

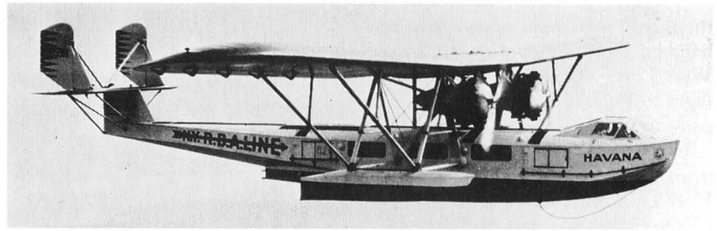
manned. Seven built, including two for the New York State Police.

Fleet Sport 9 (ATC 428, 18 June 1931). Two-seater sport model engineered by Gwinn, 125hp Kinner B-5, brake pedals in both cockpits standard. Group 2-443 (20 April, 1933) for one aircraft (msn 510) on Edo-I floats; eleven built in 1931-33 with one exported to Brazil (msn 509/PP-TAC).

Fleet 10 (added to ATC 374). This 125hp Kinner B-5 version introduced a revised cockpit profile for better protection and turtle back fuselage faired out (as on PT-6), a more rounded fin and rudder, and eliminated the cross-axle undercarriage layout. Sometimes referred to as the F10 by Consolidated. A prototype (msn 338/NC757V) was built in 1931 followed by at least twenty other US-built civil aircraft including one each to Argentina and Spain; 115 for China between 1932 and 1935; ten for Portugal (five were 10Gs with 130hp de Havilland Gipsy Major four-cylinder inline inverted engines); twenty for Romania; and sixteen for Turkey — although these last may not have been Model 10s. The prototype was also used to test several different wing sizes and shapes and different engines. Production in Canada as Model 10B; also 10A (Kinner K-5), 10E (Warner Scarab), 10F (Warner Super Scarab), 10C (Civet), 10H (Menasco C-4s), but there is no record that the last two versions were built. Over three hundred Fleet 10Gs were also built in Romania by IAR and SET.

Fleet 11 (ATC 526, 19 February, 1934). Military export version of Fleet 10 (also referred to as F11) with 160hp Kinner R-5 (designated Fleet 10D in Canada) for training, aerial gunnery, bombing, and aerial photography. Seventeen US-built aircraft (msn 513/NR13935, to China; ten to Brazil, six to Mexico). Two more aircraft (msn 549/550 X14705/ 14706) were fitted with 32ft span wings with gloves on the leading edge of the upper wing to improve 'hot and high' performance and this version was known as Model 11-32 (Canada, Fleet 10-32D). One US-built example only (msn 629/E-1) was exported to Mexico. Edo 2260 floats were available.

Fleet 16 (Group 2-566). As Fleet 10 with Douglas fir instead of spruce for wing spars, double landing wires and double wires to the underside of the tailplane. Only Canadian production as Fleet 16D — changed to 16R at RCAF request — (RCAF Finch I) with Kinner R-5, and 16B (RCAF Finch II) with Kinner B-5; one aircraft (msn 262/NC20699) was built for Consolidated with a Warner Scarab as the Fleet 16F and delivered in February 1939.



The third Commodore for NYRBA, NC659M Havana. (Stephen J Hudek collection)

In order to market the trainer, Fleet organised National Flying Schools Inc (later sold to Consolidated) and the type was used extensively throughout the United States — by 1930 with nineteen of the country's approved flying schools. With the onset of the economic depression, the aircraft price was reduced by $1,000 but by selling Kinner stock (acquired with the order for 1,000 engines), Consolidated still made money.

The soundness of the Fleet design was demonstrated by Paul Mantz in 1930 when he established a new world record for consecutive outside loops, performing forty-six in a Fleet 2 at the opening of the Curtiss-Wright airport at San Mateo, south of San Francisco. But less fortunate was demonstrator pilot Gordon E Mounce, killed when he blacked out and crashed after twenty-one outside loops at Belgrade. At the 1929 National Air Races held at Cleveland, Fleets did well in several events including coming first in the 50-mile race for women (a Fleet 2 flown by Mrs Keigh Miller). A Fleet 2 X Special was also unsuccessfully entered in that year's International Safe Aircraft Competition (Daniel Guggenheim Fund) with the wings moved 2.5in aft, the tail assembly moved 6in forward, and the wheels forward by 5in. Performance was slightly less than normal and the aircraft was tail-heavy when flaps were selected, with an alarmingly steep glide angle.

Rights to the Fleet designs in the United States were sold to the Brewster Aeronautical Corp, Long Island City, on 6 April, 1939, but no further production took place. However, the Consolidated-owned Fleet 16F (NC20699) was redesignated the Brewster-Fleet B-1 with msn 1.

The available production records indicate that 614 Model 14s were built by Consolidated at Buffalo up to the move to San Diego in 1935. But Fleets were also reported in Cuba, Japan, Paraguay, Peru, the USSR, and Siam, thus the final US-built total could be slightly more. Approximately one hundred Fleets of all variants are extant today, mostly in the USA. A few are active in Canada, along with sole examples in Argentina and Iceland.

Fleet 1

One 110hp Warner Scarab seven-cylinder air-cooled radial engine.

Span 28ft 0in; length 20ft 9in; height 7ft 10in; wing area 195sq ft.

Weight empty 1,035lb; gross weight 1,675lb; amended to 1,075lb and 1,820lb respectively with 55US gal fuel capacity).

Maximum speed 105mph; cruising speed 88mph; climb 730ft/min at sea level; service ceiling 12,200ft; range 350 miles/ 4hr endurance (24US gal fuel capacity).

Fleet 2

One 110hp Kinner K-5 five-cylinder air-cooled radial engine.

Weight empty 1,023lb; gross weight 1,575lb; amended to 1,063lb and 1,820lb respectively with 55US gal fuel capacity.

Maximum speed 113.5mph; cruising speed 88mph; climb 730ft/min; service ceiling 12,200ft.

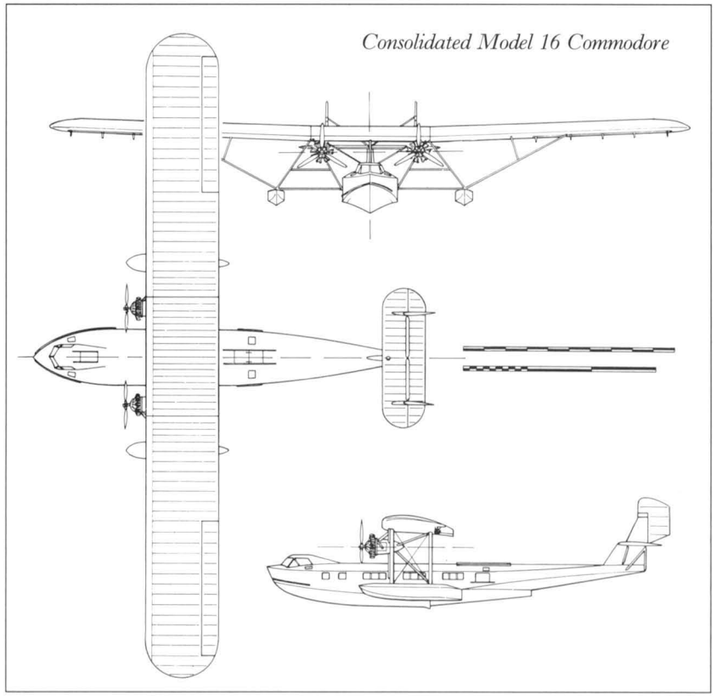
Fleet 7 (Edo I-1835 floats)

One 125hp Kinner B-5 five-cylinder air-cooled radial engine.

Weight empty 1,279lb; gross weight 1,873lb.

Maximum speed 105mph; cruising speed 88mph; climb 710ft/min. at sea level; service ceiling 12,850ft; range 265 miles.

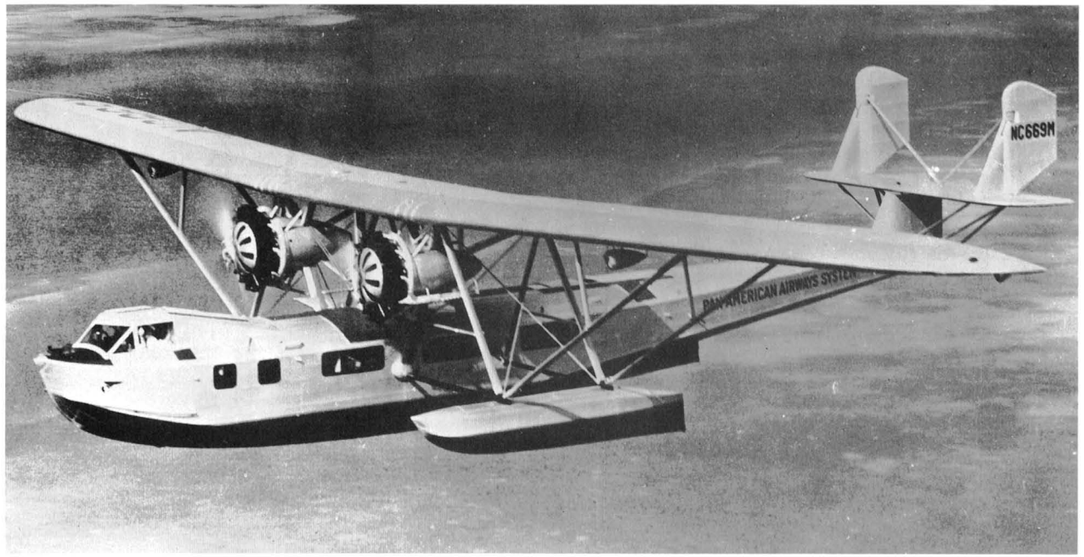
Model 16 Commodore

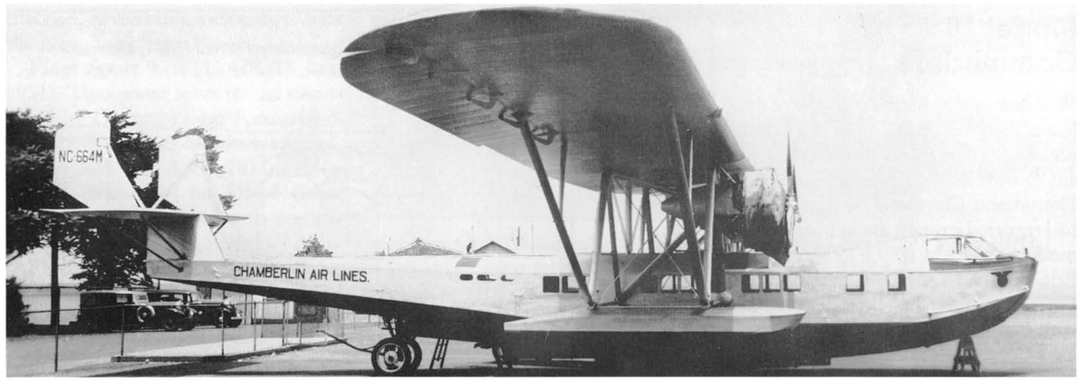


Well before the disappointment of the loss of the PY Admiral order, Fleet had obtained orders for a commercial variant known as the Commodore. The Detroit and Cleveland Navigation Co had reported it might inaugurate Commodore service by spring 1929 on Lake Erie between Detroit, Cleveland and Buffalo and there had been discussions with Pan American Airways concerning a Commodore order, but neither of these possibilities materialised. However, for some time Fleet had discussed an order with Ralph O'Neill who was organising a South American airline service. In January 1929, it was decided that Fleet, together with James H Rand Jr, would participate with O'Neill in the new venture and six Commodores were ordered by Rand's own airline, Tri-Motor Safety Airways. In April, it was decided to change the airline's name to the New York, Rio & Buenos Aires Line (NYRBA).

Powered by two 575hp Pratt & Whitney R-1860 Hornet Bs driving three-bladed metal propellers, the major change from the Admiral was the interior of the hull, which although shallow, allowed for passenger compartments 8ft wide and 5ft high. Although designed for thirty-two passengers, the initial arrangement accommodated twenty-two in two eight-passenger compartments and two drawing-rooms each seating three. The actual number of passengers on a flight was dictated by the fuel load. Pullman-style seats, with cushions that could be used as life preservers, were installed together with luxurious cabin fittings. The elegance was accentuated by a cream coloured hull with black undersides and bright coral wings. Three crew were carried, the two pilots in an open cockpit with dual rudder pedals and a control column that could be swung over for use by either man. Behind the cockpit were a lavatory, radio compartment and a 200cu ft cargo, mail or baggage hold. Access was via an aft walk-in hatchway.

Unnamed Commodore NC669M of Pan American. (D C Wigton collection)





Commodore NC664M of Chamberlin Air Lines. (A R Krieger collection)

The first 'boat (X855M) was launched on the Niagara River on 28 September, 1929, and flown by Leigh Wade and NYRBA's William S Grooch. Flown two days later to New York and thence Washington, it was named *Buenos Aires* by first lady Mrs Herbert Hoover with a bottle of non-alcoholic champagne cider on 3 October, at NAS Anacostia. A few days later, the hull was severely damaged at Havana, when Grooch bounced the aircraft off heavy swells during a demonstration with President Gerardo Machado's wife and family on board. The *Buenos Aires* was repaired at NAS Pensacola and to prevent recurrences, hull strengthening was added to all Commodores. At the same time, the cockpit was enclosed with hinged plywood panels.

The second aircraft (NC658M *Rio de Janeiro*), delayed two weeks because of hull modifications and other changes including work on the fuel lines, was flown to Port Washington, Long Island, and disassembled for display at the New York Aircraft Salon, Madison Square Garden, between 10 and 17 November. Three days later, the Commodore received ATC 258 and on the 23rd, the *Rio de Janeiro* was flown to Miami and South America by O'Neill. At Fortaleza, when flown by Cloukey and Hoobler, the starboard engine was torn off during take-off in heavy seas and the propeller entered the fuselage. There were no casualties but the *Rio de Janeiro* was grounded for one month. Thus the *Buenos Aires* entered service on the Buenos Aires—Rio route on 23 December, 1929, via Montevideo, Rio Grande do Sul, Pôrto Alegre, Florianopolis and Santos. The first South American — US air mail was flown on 19-25 February, 1930, although because of a take-off accident suffered by the *Rio de Janeiro*, some of the sectors were flown by a Sikorsky S-38, before the mail was transferred to the fourth Commodore, *Cuba* (NC660M), at Santiago de Cuba for the final leg to Miami. The third aircraft (NC659M *Havana*) had been damaged during its delivery flight when, on 19 December, during the Port of Spain — Paramaribo segment, a fuel line broke during descent and the wing caught fire. However, the aircraft was beached and saved.

On 12 February, 1930, Commodores had started Kingston (Jamaica) — Barranquilla (Colombia) flights, a 600-mile service that was one of the longest in the world at the time and certainly one of the longest over water.

In June 1928, a second batch of six Commodores had been ordered by NYRBA (at the same $100,000 price as the initial aircraft) and this was followed by two more in October. From the third aircraft, the designation was given as Model 16-1 and the 16-2, introduced in 1930 on the Buenos Aires—Montevideo 'shuttle', had seating for thirty passengers although the gross weight was unchanged. To expedite deliveries, Consolidated shipped assemblies to Langley Field, Virginia, where they were assembled and test flown from Chesapeake Bay by William B Wheatley. Flight testing resumed from Buffalo in June with the *Miami* (msn 10/NC666M).

On 29 May, 1930, the brand new *Argentina* (NC665M) took off from Washington with a *National Geographic* expedition to cover NYRBA's route and the story appeared in the July issue. On 13 August, Captain Herman E Sewell experienced double engine failure with *Puerto Rico* (NC664M) on a Cienfuegos — Havana flight but managed to put the Commodore down without injury to the eighteen passengers on board. The wing was badly damaged and the aircraft subsequently disassembled and taken to Havana for rebuilding.

By July, NYRBA had seven Commodores on line and had flown on the entire 9,000-mile (14,500 km) fifteen-country South American route (the longest in the world) for just four months when pressure was applied by the Postmaster General, Walter Brown, to merge with Pan American Airways. The official date of the acquisition was 15 September, 1930, and eleven Commodores were taken over (at a greatly reduced price) with the last three of NYRBA's order going straight to Pan American. O'Neill had founded NYRBA do Brasil in October 1929 and a year later this became Panair do Brasil under Pan American control with four, later seven, Commodores.

Eight Commodores were subsequently returned to the United States and Pan American or its subsidiary companies operated the entire production run of fourteen (one was destroyed in a Miami hangar fire in 1935) until starting to dispose of them by 1937. One was reported in use between March 1937 and July 1938 by Miami-Key West Airways on a shuttle between the two cities and another (NC664M) was used by Chamberlin Air Lines of Miami. Two were registered briefly in the Argentine, two went to the China National Airways Corporation (another Pan American subsidiary), and two were sold to the Brazilian Air Force. Another pair, sold by Panair do Brasil to Sociedad Argentina de Navegación Aérea (SANA), flew the short route from Buenos Aires to Colonia, Uruguay, during 1940-43. At least one (NC667M) was used as a Model 16T-2 by Pan American as a navigation trainer.

Two were recommissioned when Pan American acquired a 45 per cent interest in Bahamas Airways in 1943. One (msn 12) was lost on a test flight, but the other (msn 11) flew between Miami and Nassau, a service continued by Bahamas Airways until VP-BAA was damaged in a hurricane and broken up in 1949.

Undeniably ahead of its time, the Commodore was reported as reliable and trustworthy by those who flew it.

Model 16-1

Two 575hp Pratt & Whitney Hornet B nine-cylinder air-cooled radial engines.

Accommodation: 22 passengers and three crew.

Span 100ft 0in; length 61ft 8in; height 15ft 8in; wing area 1,110sq ft.

Weight empty 10,550lb; gross weight 17,600lb.

Maximum speed 128mph; cruising speed 108mph; climb 675ft/min; ceiling 11,250ft; range 1,000 miles (650US gal fuel capacity).

Model 17, 18 and 20 Fleetster

In March 1929, Fleet announced that Consolidated would build a fast six/seven-passenger and mail transport called the Fleetster. The first order, for three at $26,500 each, was placed by Tri-Motor Safety Airways on behalf of the New York, Rio & Buenos Aires Line (NYRBA), then in the process of formation with Fleet as a director.

A high-wing monoplane, the Fleetster was designed by Laddon (who reportedly wanted an all-metal, low-wing aircraft with retractable undercarriage) and project engineer Bernie Sheahan. Undoubtedly inspired by the Lockheed Vega, the unbraced cantilever wing was of spruce construction with plywood covering. But unlike the Vega it featured an all-metal monocoque fuselage, one of the first for a US-built transport, thanks to Consolidated's experience with metal construction on the Admiral. The externally strut-braced tail unit was also all-metal.

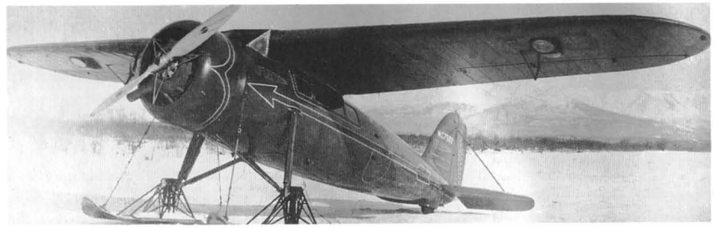
The main cabin accommodated two full-width divan seats each seating three across, either in facing or all-forward style. A 25cu ft baggage compartment was behind the cabin and a canvas bag could be suspended at the back of the rear seat for additional mail or baggage if the passenger load permitted. If desired, all the seats could be removed in favour of cargo. The enclosed cockpit also had a passenger seat but this was removed when radio equipment was carried. The tailwheel was streamlined but non-swivelling which caused some ground handling problems. Fuel capacity was 90US gal contained in two wing tanks and with a 575hp Pratt & Whitney R-1860-1 Hornet B enclosed in a low-drag NACA cowling, the Fleetster could cruise at 150mph — an impressive performance for its day.

The first Fleetster (X657M) was initially test flown by Leigh Wade on 27 October, 1929. Early flights were made with a wheel undercarriage then, after Edo floats were substituted, it was taken to Miami for trials by NYRBA. An Approved Type Certificate (number 291) for both versions (Model 17-1) was issued on 23 January, 1930.

On 7 May, ATC number 320 was assigned to the Model 20-2 Fleetster although the first of this type was not completed until June 3. This was a parasol-wing version with the pilot moved aft to an open cockpit, and the forward fuselage area converted to carry 475lb of mail or cargo. Five passengers could still be carried in the main cabin. The similar Model 20-1,

The Model 17-1 Fleetster prototype, NC657M, with Edo floats. (A R Krieger collection)

NYRBA Model 20-1 Fleetster NC673M. Note airlines's emblem underneath the starboard wing. (Wright Field)



Model 17-A Fleetster NC750V operated on skis by Pacific International Airways. (Davidson-Hudek colletion)

but with only one window each side, was certificated under a Group Two ATC (2-231) for 800lb of cargo and between one and four passengers. Three Model 20s were ordered by NYRBA and used for coast-hugging mail service. The northbound Fleetster would depart a day after the weekly Commodore flight from Buenos Aires, and flying at night, catch it up at Florianopolis, halfway to Rio, thus saving a whole day on the mail schedule to Miami.

After the takeover of NYRBA, Pan American used five Fleetsters but the wooden wings deteriorated in the humid climate and by mid-1932 they were all stored in the United States. Fleet offered to rebuild the aircraft with a new, 50ft span metal wing (tested on NC700V) but this proposal was turned down by the airline. In 1934, one (NC675M) was sold to subsidiary Aerovías Centrales as XA-BEK and used on the Mexico City — El Paso route but the others were scrapped.

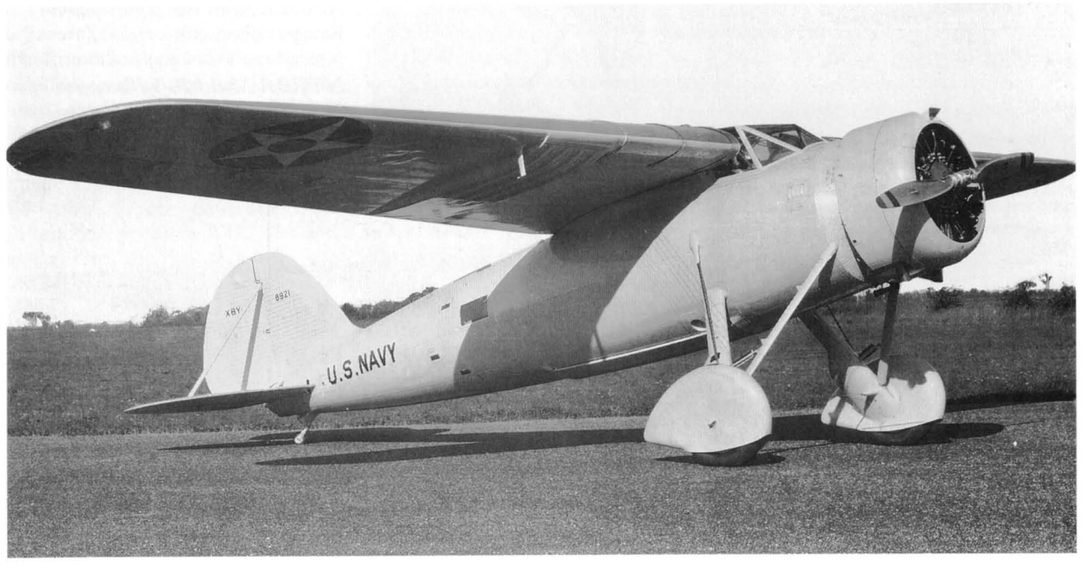
There were several variations of the basic Model 17 produced. Following tests with the Consolidated demonstrator (NC700V) the USAAC placed an order for a single Y1C-11 (31-380) with dual controls and replaced the Hornet with an equally powerful Wright R-1820-1. Flown by Capt Ira C Eaker, it was used by the Air Corps Chief of Staff, Maj-Gen James E Fechet, and Assistant Army Secretary F Trubee Davison. As a result, three Y1C-22s (31-469/471) with similar powerplants were acquired. The salvaged fuselage of one of these was later used by the Materiel Division to study the feasibility of building a pressurized cabin.

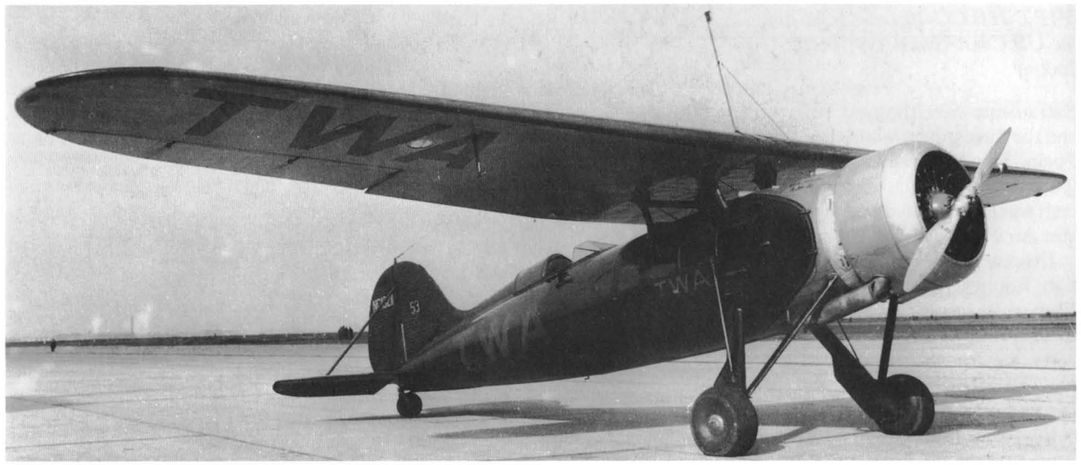
The sole 17-2C (Group 2-273, 25 September, 1930, then ATC 369, 29 September, 1930) was NC750V (msn 10) fitted with a nine-cylinder 575hp Wright Cyclone R-1820-E for Edwin Lowe, Jr, of San Francisco. Later it was sold to Pacific International Airways in Anchorage and subsequently rebuilt at the factory with an extended fuselage and a 50ft span wing (Group 2-402, 27 February, 1932). The 17-2H Special was a five/six-seat executive version, with a 525hp Hornet B-1, and 5,600lb gross weight. Two (msn 7 & 8) were built under Group 2-331 (9 March, 1931) for Col Robert McCormick of the *Chicago Tribune* and George F Harding, Illinois State senator, respectively. Harding took his aircraft by ship to Europe for an air tour of the continent with his wife and two friends with William S Brock (transatlantic flyer) as pilot.

The prototype Fleetster, was sold back to Consolidated and fitted with a Pratt & Whitney R-1340-G Wasp as a Model 17GW-1 (Group 2-341, dated 22 April, 1931).

The Model 17-A (ATC 486, 1 June, 1932) had a 29in fuselage stretch to accommodate an extra bench-seat in the cabin for two more passengers (total nine), a 5ft increase in wing span, 575hp Wright Cyclone R-1820-E, and a stalky low-drag main undercarriage (originally designed for the Model 18). Three were built for The Ludington Line and used on four daily round- trip 80-minute flights between New York and Washington (Hoover Airport). All were passed to Pan American's subsidiary, Pacific Alaska Airways, a year later and converted as 17-AFs with a fuel capacity of 200US gal and gross weight increased to 6,500lb. Two (NC703Y/704Y) were sold to the

Model 18 Fleetster, the XBY-1 A-8921, photographed on 17 September, 1932. (Convair)



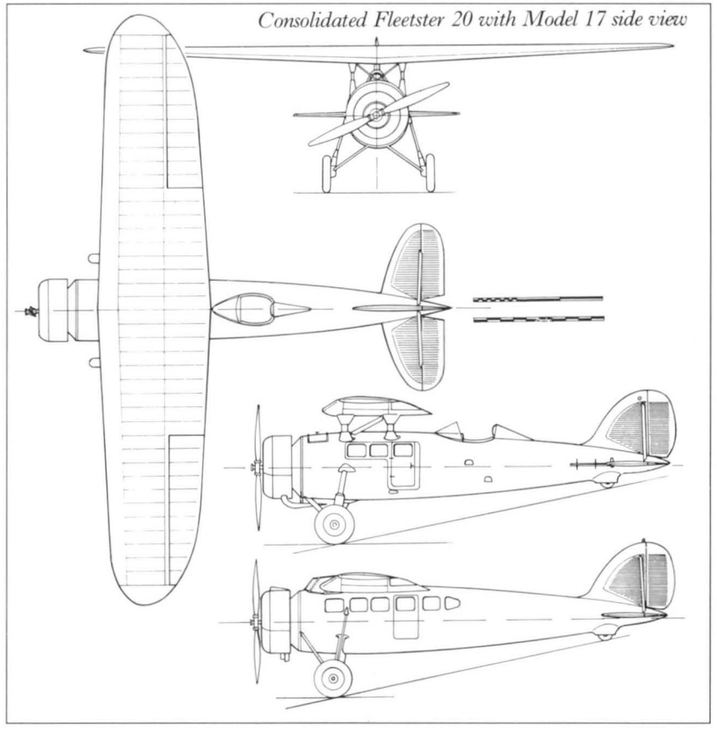


Fleetster 20-A NC13211 of Transcontinental & Western Air. (A R Krieger collection)

Soviet trading company, Amtorg, in March 1934 to search for members of an Arctic expedition stranded after their vessel *Chelyuskin* had been crushed by ice. Delivered to Mark Slepnev and Sigismund Levaneskii in Anchorage, they were registered URSS-MS and -SL respectively. Slepnev made a successful search and rescue, but Levaneskii's machine was wrecked in a forced landing en route to the site.

Also completed in 1932, the Model 18 had a stressed-skin 50ft all-metal wing of different taper and was designed around a 1,000lb bomb as a two-crew naval bomber for aircraft carrier deployment. The bomb load was carried internally and the bomb-bay door was a curved panel that rotated upwards to the left. The wing contained flotation bags and in the leading edge was an integral fuel tank, the first incorporated into a metal wing. Powered by a 600hp Wright R-1820-78 Cyclone, one was ordered with the designation XBY-1 (BuA-8921). Another fuselage was also built and static tested by Henry Mandolf and his engineering team to check the strength for naval operations. Delivered to NAS Anacostia on 26 September, the prototype ended trials after 50 flights and 38$^{1}/_{2}$ hours when it suffered major damage when the undercarriage collapsed on landing at NAS Norfolk, Virginia, on 13 April, 1933.

The final Fleetster model was the 20-A (ATC 494, 15 September, 1932) built for Transcontinental and Western Air (TWA). This featured the larger wing from the 17-A, a bubble canopy over the cockpit with rear decking extending to the tail, fuel capacity increased to two 80US gal wing tanks and one 35US gal centre-section tank, and a swivelling tailwheel in a streamlined fairing (later removed). One of the original Model 20s had been tested by Larry Fritz, a TWA pilot, at Buffalo including a series of loops and rolls to verify the soundness of the parasol wing layout. As a result, seven 20-As were acquired and these were introduced on 10 September on a shuttle-type service for the Detroit–Toledo–Ft Wayne–Indianapolis route which was advertised as a 160mph schedule. One crashed in January 1935 and the survivors (TWA's last single-engined type) were withdrawn from service a month later. Subsequently, two went to Condor Air Lines of Alameda, California, which operated a sporadic service to Salinas, Monterey, and



Consolidated Fleetster 20 with Model 17 side view

Y1PT-11B CG-10 (ex-32-395) of the US Coast Guard. (via Terry Judge)

Sacramento over the next two years, and the three others found their way to Spain. Known locally as *La Pantera* (panther), one of the Republican aircraft was incorporated into the Nationalist Air Force in 1939.

Despite the several innovative design features of the Fleetster series, Fleet never considered the type a great success and of the twenty-six built, none are known to survive today. However, the XBY-1 static test fuselage was purchased by a Consolidated employee, converted into a trailer and used to haul his belongings to San Diego when the company moved west in 1935. The trailer was subsequently equipped with a sound system as an announcement vehicle and in 1969, was sold to a Laguna Niguel, California, resident who re-modelled it into a twelve-bed camper!

Model 17

One 575hp Pratt & Whitney R-1860 Hornet B nine-cylinder air-cooled radial engine.

Accommodation: Pilot and up to seven passengers (five in seaplane).

Span 45ft 0in; length 31ft 9in; height 10ft 2in; wing area 313.5sq ft.

Weight empty 3,326lb (seaplane 3,822lb); gross weight 5,300lb (later 5,600lb; seaplane 5,570lb).

Maximum speed 180mph; cruising speed 153mph; climb 1,200ft/min at sea level; ceiling 18,000ft; range 675 miles.

Model 17-A

One 575hp Wright Cyclone R-1820-E nine-cylinder air-cooled radial engine.

Span 50ft 0in; length 34ft 2in; height 9ft 7in; wing area 361.5sq ft.

Weight empty 3,639lb; gross weight 6,279lb.

Maximum speed 180mph; cruising speed 155mph; climb 1,000ft/min at sea level; ceiling 18,000ft; range 380 miles.

Model 20-A

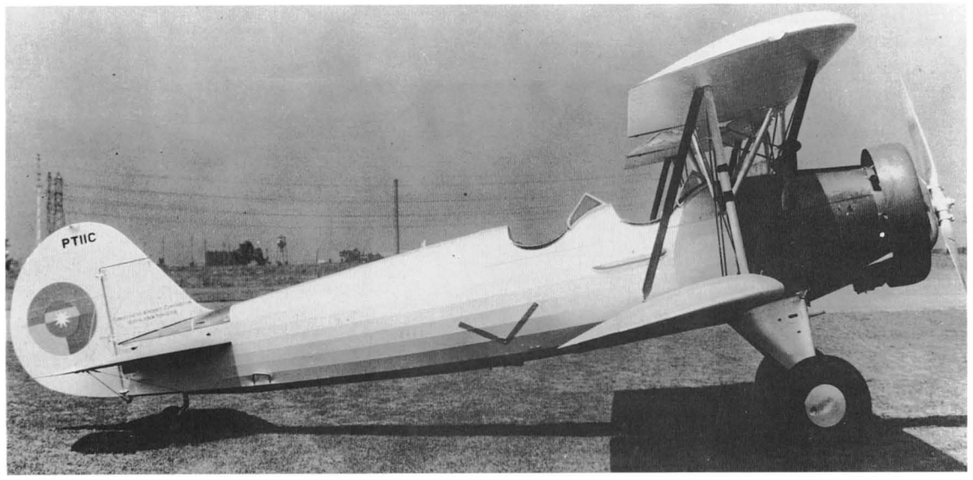
One 575hp Pratt & Whitney Hornet Bl nine-cylinder air-cooled radial engine.

Span 50ft 0in; length 33ft 9in; height 12ft 0in; wing area 361.5sq ft.

Weight empty 3,850lb; gross weight 6,800lb.

Maximum speed 175mph; cruising speed 160mph; climb 1,050ft/min. at sea level; ceiling 18,000ft; range 800 miles.

Colombia took delivery of eighteen PT-11Cs in 1934. (A R Krieger collection)



Model 21 (PT-11/12, BT-6/7)

Late in 1930, the US Army held a design competition for a new trainer to replace the PT-3. Joe Gwinn designed the Model 21-A, based on the PT-3 but with more graceful lines, and a prototype, known as the XPT-933 was flown in February 1931 by Bill Wheatley, just eight weeks after design work started. A 170hp Kinner engine was installed, but the 21-A was designed to be adapted for more advanced training with up to 400hp engines. Additional wing fittings were provided in order to accommodate engine changes without stability problems.

Four were ordered for evaluation by the Army with 165hp Continental R-545-1 engines, designated Y1PT-11 (31-593/596). All were delivered in May 1931. Later, two were converted to PT-11D standard, the third to a BT-6, and the fourth to the Y1PT-11A with a 175hp Curtiss Challenger R-600-1 engine. Later this became a PT-11A then, with a 180hp Lycoming YR-680-1, the Y1PT-11C.

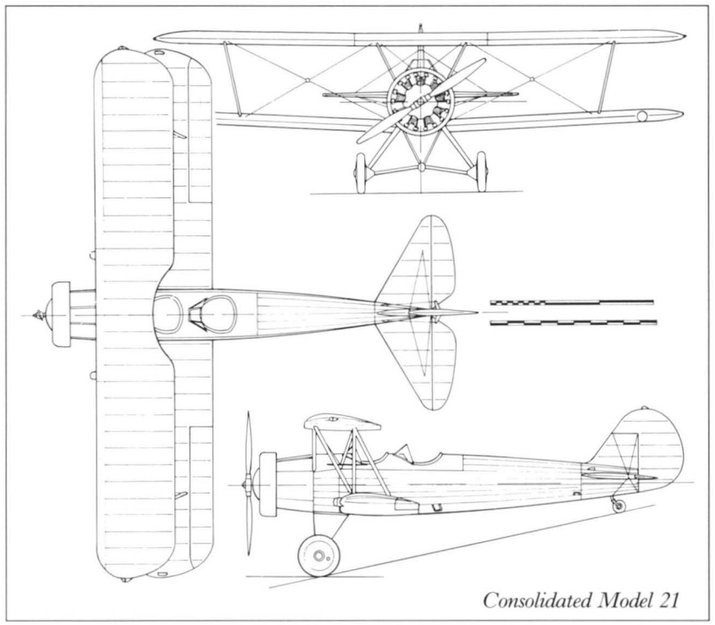
One of the YPT-11s was also flown with a 210hp Kinner YR-720-1 as a Y1PT-11B, the designation of five more similar aircraft (32-367/371) delivered from July 1932. Subsequently, these were redesignated PT-11B then converted to PT-11D standard. A sixth Y1PT-11B (32-395) was transferred to the Coast Guard (CG-10, later 310, finally V110) with a 165hp Wright J-6-5, but later was converted again with a 220hp Lycoming R-680 and designated N4Y-1.

Twenty-one Y1PT-11Ds (32-372/392) were delivered between May and July 1932 with 220hp Lycoming R-680-3 nine-cylinder radials and were later designated PT-11Ds. In 1934, the Navy ordered three similar XN4Y-1s (BuA 9456/9458) and the final order of this series was for eighteen PT-11Cs with the Wright 760-E7 engine and convertible wheel/float undercarriage for Colombia (msn 37/54) delivered July-August 1934. The last of these was withdrawn from use in 1952.

Ten Y1PT-12s (32-357/366) were basically similar except for a 300hp Pratt & Whitney Wasp Junior R-985-1 engine and minor equipment changes. Delivered in April/May 1932, they were designated PT-12,, then Y1BT-7, and finally BT-7. One unidentified aircraft was marked as the XBT-937, but this was possibly a civil 21-C. The sole Y1BT-6 was a Y1PT-11 (31-595) fitted with a 300hp Wright J-6 (R-975-1), later designated BT-6, then converted to a PT-12D. One BT-7 (32-362) was assigned to Col H M Turner, US Air Attaché in London, and allocated, but did not carry, RAF serial DR629 and was still in use in 1944.

The equivalent civil Model 21-C (NR784N msn 1) received Approved Type Certificate Group 2-405 (12 April, 1932) with a 300hp Wasp Junior A engine and a gross weight of 3,100lb and was primarily intended for overseas markets. Leigh Wade received one in December 1932 (msn 14) for use as a demonstrator in South America and this was sold in Argentina in 1934. A third aircraft (msn 12 NC13289) was sold to a Mr A B Echols on 13 July, 1934.

The first aircraft was used for a sales trip to China in 1933 by Clint Warner.



Consolidated Model 21

Returned to the USA, it was stored engineless then rebuilt with a 400hp Wasp Jr for demonstrations to the Mexican Air Force which resulted in an order for ten. On 25 January, 1936, it crashed at Mexico City killing a Mexican general on board. Warner died of his injuries three weeks later.

As Consolidated had moved to San Diego, the Mexican order (with the 420hp Wasp Jr SB) were built by Fleet Aircraft at Ft Erie in Canada. Delivered in November and December 1936 with two machine-guns, one fixed and one flexible in the observer's cockpit, at least one saw service during the Cedillista Rebellion of May 1938. Several were transferred to the Naval Aviation School at Veracruz in late 1943.

The Fleet 21K (330hp Jacobs L-6B) was also offered for sale in Canada but not built. However, the eleventh Canadian-built 21M, a demonstrator, was converted to this standard in 1947. Still in existence, this is the only known survivor of the series although one other may be extant in Mexico.

PT-11D

Span 31ft 7in; length 26ft 11in; height 9ft 8in; wing area 280sq ft.

Weight empty 1,918lb; gross weight 2,585lb.

Maximum speed 118mph at sea level; climb 5,000ft/7.4min; ceiling 13,700ft.

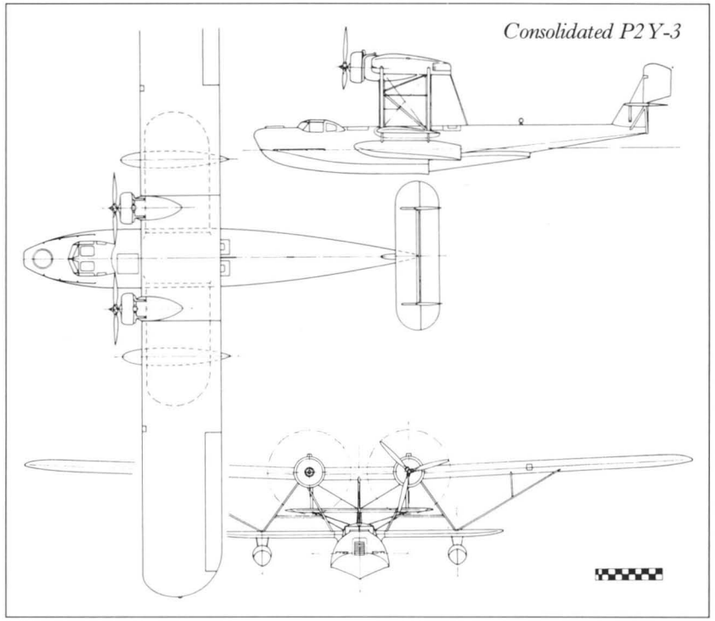
Model 22 Ranger (P2Y)

Although Consolidated lost the production contract for the PY Admiral to Martin, Laddon improved on the design as the Buffalo plant was completing Commodore production. A single prototype XP2Y-1 Ranger (BuA-8939) was ordered on 26 May, 1931, followed on 7 July by a production contract for twenty-three P2Y-1s (BuA-8986/9008 msn 1-23). The P2Y-1 had the same 100ft parasol wing as the Admiral but became a sesquiplane with a 45ft 3in span wing mounted lower, at the top of the hull, replacing the struts that had supported the stabilizing floats. The cockpit was now enclosed in Commodore style and two 575hp Wright R-1820-El Hornets were installed beneath the top wing with a third, similar engine, strut-mounted on the centreline above the wing. All three engines were enclosed by NACA narrow-chord ring cowlings and riveted alloy fuel tanks were built into the wings.

First flown from Buffalo by Bill Wheatley with Laddon aboard on 26 March, 1932, the XP2Y-1 was tested at NAS Anacostia the following month. The third engine was discarded and testing began with the twin-engined version on 18 May. All P2Y-1s were delivered between 22 December, 1932,

and 27 June, 1933, in this configuration to VP-10 and VP-5. Six P2Y-1s of the latter squadron set a new nonstop formation flight distance record between Hampton Roads, Norfolk, Virginia, and Coco Solo, Canal Zone (2,058 miles) on 7-8 September, 1933, in 25hr 19min under the command of Lt-Cdr Donald M Carpenter. This flight beat substantially the previous world record held by Gen Italo Balbo across the South Atlantic.

A second long-distance formation flight occurred when VP-10 was transferred to Pearl Harbor, Hawaii, from Coco Solo. Six newer P2Y-1s with longer range were passed to VP-10 from VP-5 and these left the Canal Zone on a 14-hour flight to Acapulco, Mexico, on 7 October, 1933, then on to San Diego. On 10 January, 1934, the six P2Y-1s left Alameda, California, for Pearl Harbor led by Lt-Cdr Knefler 'Soc' McGinnis and his co-pilot, Cdr Marc A Mitscher, arriving safely the next day despite having flown throughout the night in fog. The elapsed time was 24hr 56min for the 2,408 miles. President Franklin D Roosevelt sent a telegram congratulating the men 'on the greatest undertaking of its kind in the history of aviation.'



The last Navy P2Y-1 (A-9008) on the production line was modified to the XP2Y-2 in August 1933 with 750 hp R-1820-88s raised to the leading edge of the wing in NACA cowlings. The change reduced drag considerably and twenty-one P2Y-1s were thus modified as P2Y-2s with kits supplied by Consolidated. Two unmodified aircraft were built for export. The P2Y-1C (msn 1) was delivered to Colombia on 31 December, 1932, and remained in service until 1948; the P2Y-1J (21966) to Japan in January 1935. Assembled by Kawanishi, the latter was flown on 12 April and used for comparative tests; then saw airline service during the Second World War.

The P2Y-1 in original trimotor configuration at Buffalo on 14 April, 1932. (Convair)

On 27 December, 1933, the Navy ordered twenty-three P2Y-3s (BuA-9551/A-9571; A-9618/A-9619 msn 1-23) which were of similar configuration but with R-1820-90 engines and additional 420US gal fuel to make a total capacity of 1,635gal. The first aircraft was delivered to VP-7 in January 1935, followed by VP-4. In 1939, the P2Y was operational with VP-14, VP-15, VP-19, VP-20, and VP-21 but by the end of 1941, all P2Ys had been withdrawn from use and stored at Pensacola.

Six P2Y-3As with GR-1820-F52 engines were ordered by Argentina in May 1936 and delivered in August-September 1937 to replace Supermarine Southamptons. This batch brought total production to fifty-five aircraft. In service with Escuadrilla de Patrulleros at Puerto Belgrano, the Rangers continued in use until replaced by PBYs in 1947.

P2Y-3

Two 750hp Pratt & Whitney Hornet R-1820-90 nine-cylinder air-cooled radial engines.

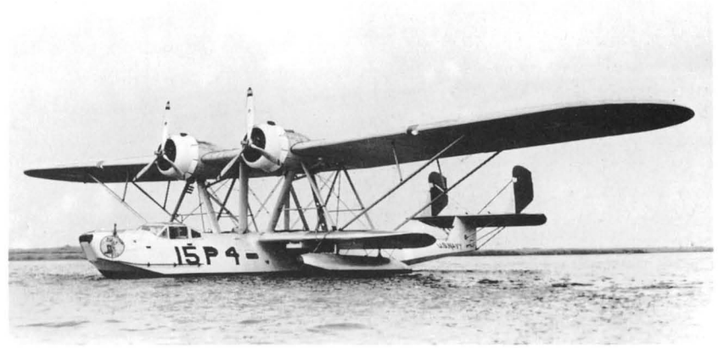
Crew: 5

Armament: One flexible 0.30in Browning in bows, two dorsal gun hatches behind wings and up to 2,000lb of bombs under the wings.

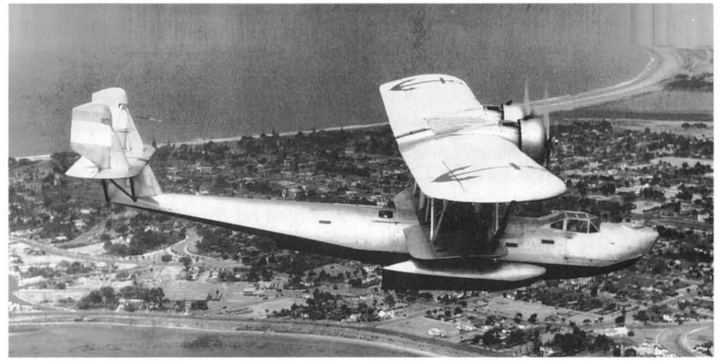
Span 100ft 0in; length 61ft 9in; height 16ft 3in; wing area 1,514sq ft.

Weight empty 12,769lb; maximum gross weight 25,266lb.

Maximum speed 139mph at 4,000ft; cruising speed 117.5mph; initial climb 650ft/min; service ceiling 16,500ft; range 1,180 miles with 2,000lb bomb load (1,620US gal fuel capacity).



P2Y-2 Ranger of VP-15. (Gordon S Williams)



The final six Model 22s were built at San Diego for Argentina as P2Y-3As. (Convair)

Model 24 (XB2Y-1)

By 1932, the Navy's requirement for an aircraft to carry a 1,000lb bomb had changed from a horizontal delivery to that of a dive-bomber. The Bureau of Aeronautics drew up a basic two-seat biplane design (No.110) and prototypes were ordered from two companies on 22 June, 1932. B Douglas Thomas worked on details of the Consolidated design, the XB2Y-1 (BuA 9221), delivered on 28 June, 1933.

Powered by a 700hp Pratt & Whitney Twin Wasp XR-1535-64 fourteen-cylinder air-cooled radial, construction had to be extremely strong to withstand 9g pull-outs. Thus, Thomas used a solid steel block to build a large portion of the centre section but this method of construction proved extremely expensive.

Trials were not successful and the competition was won by the Great Lakes XBG-1 which was put into production. Shortly after, Thomas resigned from Consolidated. The XB2Y-1 was subsequently modified to 'Scout' configuration with the bomb trapeze and belly tank removed, and changes to the cowling, which resulted in a service ceiling of 23,400ft being attained at NAS Hampton Roads, Virginia, in March 1934.

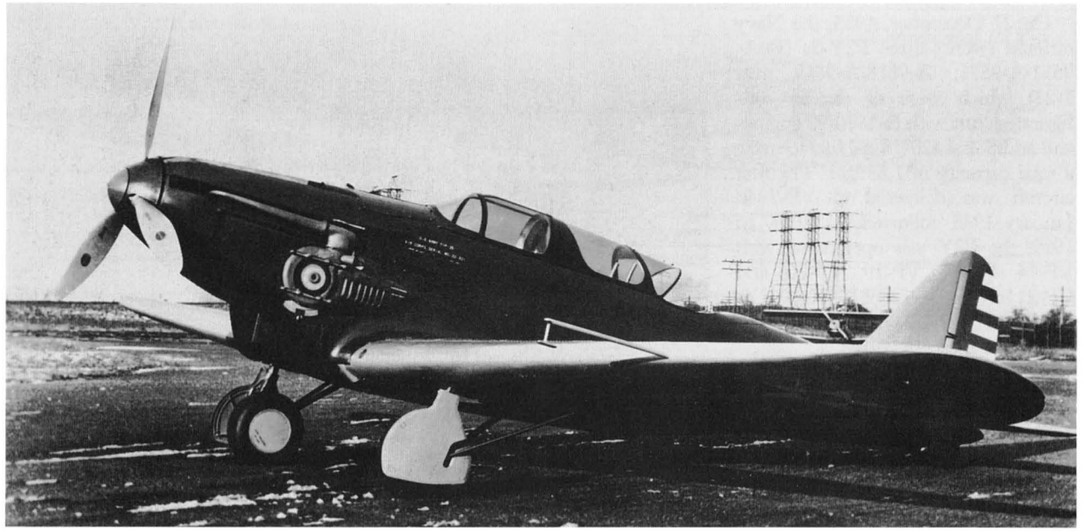
Model 24 XB2Y-1 A-9221 at Buffalo on 26 June, 1933. (Convair)

Armament: One fixed and one flexible 0.30in machine-gun.

Span 36ft 6in; length 27ft 11in; height 10ft 10in; wing area 362sq ft.

Weight empty 3,538lb; gross weight 6,255lb.

Maximum speed 182mph at 8,900ft;



climb 12,200ft/10min; ceiling 22,800ft; range 487 miles (214US gal fuel capacity).

Model 25, 26 and 27 (P-25, P-30/PB-2, A-11)

On 19 October, 1931, the prototype YP-24 crashed during tests at Wright Field and eight days later it was figuratively followed by its manufacturer, the Detroit Aircraft Company. A combine which included the Lockheed Aircraft Corp, the Detroit concern used the proven wooden wing of the Altair and its retractable undercarriage mated to an all-metal fuselage designed by Robert J Woods. Initially known as the XP-900, the two-seat pursuit (a gunner sat facing rearwards) had found favour with the Army because, with its sleek lines and a 600hp Curtiss V-1570-23 Conqueror twelve-cylinder liquid-cooled inline engine, it was able to reach 214mph. Four Y1P-24s and four Y1A-9 attack versions had been ordered on 23 September, 1931, the latter based on the Detroit XP-938, but with Detroit Aircraft's demise, these were not built.

Consolidated hired Woods immediately and after making refinements, submitted a new design which was ordered as the Model 25 Y1P-25 in March 1932. Changes included all-metal wings, a larger tail, the substitution of metal for fabric covering on the tail control surfaces, and a turbo-supercharger for the V-1570-27 engine

The first Y1P-25, 32-321, at Buffalo on 22 November, 1932. (Convair)

mounted on the port side. Thanks to this feature, the Y1P-25 achieved a maximum speed of 247mph despite a 700lb increase in weight.

This was only Consolidated's second experience with all-metal wings (the first had been on the XBY-1) and construction was slow and costly. The first Y1P-25 (32-321) was delivered to Wright Field on 9 December, 1932, but crashed on 13 January, 1933. A week later a similar fate befell the second redesignated prototype (32-322), XA-11 (Model 27). In addition to the Y1P-25's armament of two forward fixed and one flexible machine-gun, the XA-11 had two more guns in the nose and racks for up to 400lb of bombs.

The accidents, however, were not considered to be a fault of the design and a contract for four P-30s (33-204/207) each with a 675hp V-1570-57 Curtiss two-blade constant-speed propeller, simplified undercarriage, and revised cockpit canopies, and four similar A-11s (33-308/311) with -59 engines without superchargers was approved on 1 March, 1933. Tests began in January 1934 with the result that many pilots complained that the gunner, in a partly open cockpit, was of limited value, as his position ensured that blackout would occur when manoeuvring started.

Despite this failing, on 6 December, 1934, fifty Model 26 P-30As (35-1/50) were ordered (redesignated PB-2A in 1935 before delivery) with 700hp V-1570-61 engines, a controllable-

The non-turbosupercharged second Y1P-25 (32-322) was later redesignated XA-11. (Wright Field)

pitch propeller and oxygen. The first aircraft type off the new production line at San Diego, the initial flight was made on 17 December, 1935. With the latest Prestone-cooled Conqueror engine and an improved General Electric F-2H supercharger, the PB-2A achieved 274mph at 25,000ft. Unfortunately, the first PB-2A crashed at Wright Field in late May.

Production deliveries were completed by July 1936 to the 27th Pursuit Squadron, 1st Pursuit Group, at Selfridge Field, Michigan. A few were also operated by that group's 94th squadron. A year later, the group converted to Seversky P-35s and the PB-2As passed to the 33rd, 35th and 36th Squadrons of the 8th Pursuit Group at Langley Field, Virginia.

In the Mitchell Trophy Race at Selfridge Field on 17 October, 1936, a PB-2A won, flown by Lt John M Sterling at 217.5mph. In March 1937 Lt W R Robertson flew a PB-2A to 39,200ft over Langley but high altitude flight was seldom performed by squadrons because of the expense, inconvenience, and discomfort for the crew in bulky suits.

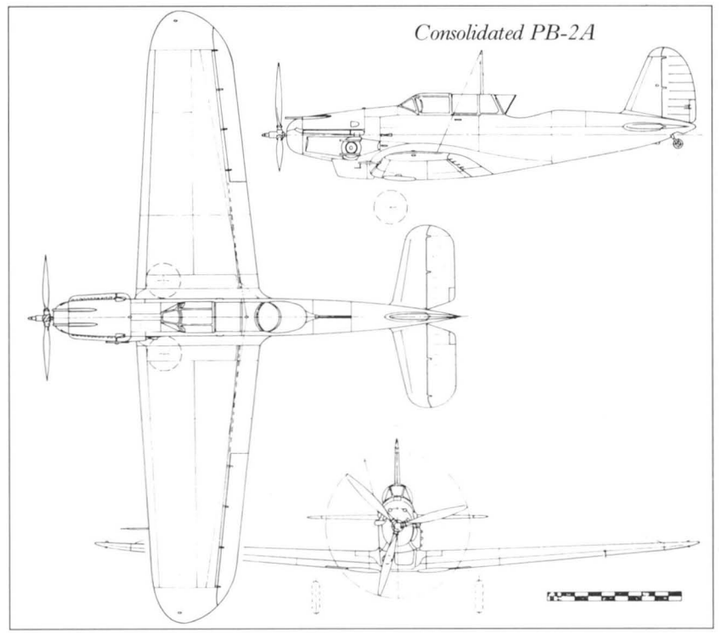
In spring 1939, the 8th Pursuit Group re-equipped with Curtiss P-36s and the thirty-five or so surviving PB-2As were transferred to Maxwell Field, Alabama. By 1941 most were out of use, the last was donated to a ground school in March 1942.

The PB-2A was the only single-engined two-seat fighter to attain operational status with the USAAC, the first fighter in service with the USAAC to have a fully retractable undercarriage, the first with a constant-speed propeller, and the first successful application of a supercharger to an operational military aircraft. However, the two-man fighter design was out-dated by the time it appeared.

One PB-2A (35-7) was converted to single-seat configuration for comparative tests in April 1936 for a Boeing P-26 successor. Another (35-26) was used to test a laminar flow aerofoil in 1940 with a new structure built over the existing wing.

The XA-11A was an A-11A re-engined with a 1,000hp XV-1710- 7. Also designated in May 1932, but not built, were the YP-27 and YP-28 with a 550hp Pratt & Whitney Wasp R-1340-21 and a 600hp R-1340-19 air-

A PB-2A of 94th Pursuit Squadron, Selfridge Field, Michigan. (A R Krieger)



cooled radial respectively. The similarly-projected XP- 33 would have had an 800hp Twin Wasp R-1830-1.

PB-2A

One 700hp Curtiss Conqueror V-1570-61 twelve-cylinder liquid-cooled vee engine with a General Electric F-2H turbosupercharger

Armament: Two fixed 0.30in machine-guns and gunner with similar weapon and ten 17lb fragmentation bombs.

Span 43ft 11in; length 30ft 0in; height 8ft 3in; wing area 297sq ft.

Weight empty 4,306lb; gross weight 5,643lb.

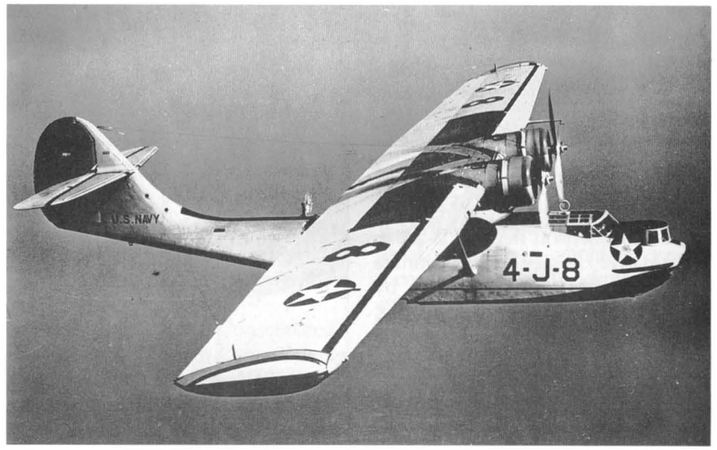
Maximum speed 274mph at 25,000ft; 255.5mph at 15,000ft; 214mph at sea level; cruising speed 215mph at 15,000ft; initial climb 15,000ft/7.78 min; service ceiling 28,000ft; range 508 miles (180US gal fuel capacity).

Model 28 PBY Catalina (Canso), BN Nomad

Well before the P2Y Ranger entered service with the US Navy, Laddon had ideas for a more efficient flying-boat powered by the new Pratt & Whitney Twin Wasp R-1830 fourteen-cylinder air-cooled radial engine. The new design, the Model 28, was produced for over ten years in six different locations becoming the most numerous and, possibly, most famous flying-boat ever.

Design work on the new patrol aircraft, designated XP3Y-1, began in earnest in spring 1933 and on 28 October, the Navy ordered a prototype along with a competing design from Douglas, the XP3D-1. Consoli-

The first of sixty PBY-1s, 0102 of VP-6 at NAS North Island. (Stephen J Hudek collection)



PBY-1 0132 of VP-4. (Davidson-Hudek collection)

dated's all-metal design retained the general hull outline of the P2Y, but introduced a single cruciform tail devoid of external bracing. The broad parasol wing, actually fabric covered aft of the rear spar, was supported by a single pylon aided by a single pair of lift-struts on each side and contained integral fuel tanks. The pylon itself housed the flight engineer's station. Also unique were stabilising floats which retracted upwards to become wingtips in flight. The two 825hp R-1830-58 engines were en-closed in nacelles mounted on the leading edge of the wing and for the first time, engine exhaust was used for a de-icing system. Armament consisted of four 0.30in guns in nose, waist and ventral positions and a 2,000lb bomb load carried on external underwing racks. The design innovations were such that Laddon applied for, and received a patent.

Other powerplant options were also studied, including the XP3Y-A variant with 1,100hp Allison liquid-cooled engines and pusher propellers, and a four-engined XP3Y-2.

The prototype (BuA 9459) was completed at Buffalo by late February 1935, but as the Niagara River was frozen, it was taken by rail to NAS Anacostia for assembly and flight tests. The first flight was made on 21 March, by Bill Wheatley, with Laddon as passenger. Trials indicated that while the XP3Y-1 was not perfect, particularly in directional stability which had necessitated experiments with a revised rudder shape, it comfortably exceeded contract performance requirements. Although the rival XP3D-1 had completed its tests six weeks earlier, an order for sixty aircraft placed on 29 June went to Consolidated, because of its lower price. The production aircraft were designated PBY-1, indicating that the substantial weapons load had reclassified the design into the patrol bomber category. The Navy also specified modifications to allow the carriage of two 2,167lb Mark XIII torpedoes on the underwing bomb racks.

Further tests continued with the prototype at NAS Norfolk before its move to the new factory at San Diego. In order to prove the desired 3,000-mile range, on 14-15 October, 1935, Lt Cdr Knefler McGinnis with five crew flew nonstop from Cristobal Harbor, Coco Solo, Canal Zone, to NAS Alameda, California (3,443 miles) in 34hr 45min in the XP3Y-1, a new world distance record for seaplanes. After display at the plant dedication in San Diego on 20 October, it was modified as the XPBY-1 with 900hp R-1830-64 engines, a rotating nose turret, and extension of the hull beneath the rudder, and flown again on 19 May, 1936.

Deliveries of production PBY-1s (Model 28-1) began in October 1936 to VP-11 and these were quickly followed by fifty PBY-2s (Model 28-2), similar except for a one-piece tailplane with inset elevators. The sixty-six PBY-3s (Model 28-3) had the 1,000hp R-1830-66 which caused the carburetor air-intake scoop to be repositioned on top of the nacelle. A policy was established whereby units would ferry their new aircraft from San Diego following transition to their bases. Thus, mass delivery flights to Pearl Harbor and Coco Solo became routine although they attracted much attention.

The first commercial Model 28-1 was built for Dr Richard Archbold, leader of an American Museum of Natural History expedition to Netherlands New Guinea. Registered NC777 and named *Guba* (a Motu word meaning squall) it was delivered to

The second Guba. (A R Krieger)

New York in June 1937. While *Guba* was being refitted, the well known Russian aviator Sigismund Levaneskii and five crew disappeared on an attempted trans-Polar flight. Desperate for long-range aircraft to search for the flyers, the Soviet Government acquired *Guba* and enlisted Sir Hubert Wilkins, the Arctic explorer, to lead the month-long unsuccessful search. *Guba* was eventually flown to the USSR and flew with the Soviet Navy until reportedly destroyed at Moller Bay, Novaya Zemlya, in late July 1942 by shelling from a German U-boat.

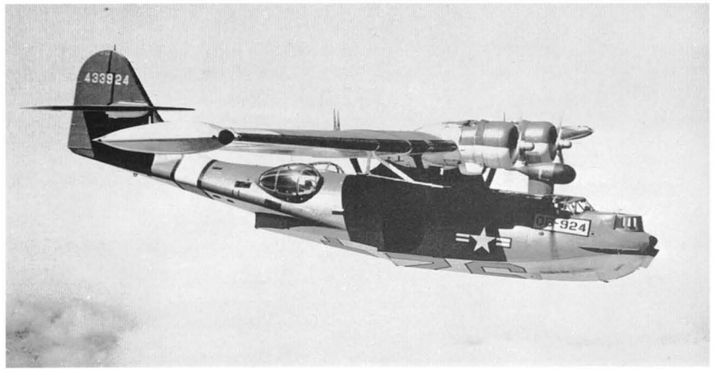
But before they received *Guba*, the Soviets ordered three Model 28-1s in February 1937, ostensibly as cargo and mail carriers, and obtained a licence to manufacture the type. As the Wright Cyclone R-1820 was already built in the USSR, this engine was chosen. One aircraft with R-1820-G3 engines was completed and flown at San Diego then shipped along with two aircraft in sub-assembly form. One of the latter used screws instead of rivets to facilitate disassembly to aid setting up a production line at Taganrog, near Rostov, on the Sea of Azov. Because of over 600 engineering changes, production of the GST (Gidro Samolyet Transportnyi, or hydro aircraft transport) did not get underway until 1940. Despite its name, nearly all were used for patrols by the Navy except for some civil versions for Aeroflot, designated MP-7. With 950hp M-87 or 1,000hp M-62IR engines the GST was faster than the PBY, but lacked its range. Some 150 are estimated to have been built before German forces captured the factory in October 1941. One was impressed into the RAF in 1941 after its defection to Cyprus from the Crimea. Believed still in service in small numbers in 1954, the GST received the reporting name of *Mop* by the Air Standards Coordinating Committee.

Archbold took delivery of a second *Guba* (Model 28-2) also registered NC777 in December 1937. Piloted by Russell Rogers and Steve Barinka, with navigator Lewis Yancey, radio operator Ray Booth, and flight engineer Gerald Brown, *Guba* left San Diego on 2 June, 1938, for Hollandia via Honolulu and Wake Island. During the next eleven months, 168 flights were made in New Guinea, including many alightings on Lake Habbema, 200 miles inland and at 11,000ft. The British and Australian authorities then enlisted Archbold's participation in a survey of an air route across the Indian Ocean. A nonstop flight was made from Sydney to Port Hedland, Western Australia, then *Guba* routed via Batavia (now Jakarta), Christmas Island, Cocos Islands, Diego Garcia, and Mahé to Mombasa which was reached on 21 June. Returning home, Africa was crossed in two hops, stopping on Lake Victoria and at Coquilhatville, on the Congo. The South Atlantic was bridged from Dakar to St Thomas, West Indies, thence on to New York. On 6 July, *Guba* returned to San Diego, completing the first around-the-world flight by a seaplane and the first by any aircraft to circle the globe's greatest diameter.

Only thirty-three PBY-4s with 1,050hp R-1830-72s and propeller spinners were ordered but two more were built as commercial Model 28-4s. American Export Airlines took delivery of NC18997 *Transatlantic* in June 1939 and the following month the British Purchasing Commission accepted one (P9630) for evaluation. The latter, with R-1830-S1C3C engines and marked as 'N-P9630', was flown by the *Guba* crew from San Diego via Botwood, Newfoundland, to the Marine Aircraft Experimental Establishment at Felixstowe, the first transatlantic delivery of a military aircraft. The Commission had not been impressed by the PBY's flying characteristics and felt that its prospects for survival in a combat area were marginal. However, the Saro Lerwick, considered the better choice because of its power-operated turrets, was clearly not going to be viable and therefore an alternative might have to be found.

Three PBY-4s were modified with a new tail, with a straight trailing edge on the rudder, the waist gun positions enclosed by 'blisters' instead of sliding hatches, and revised engine nacelles. The last (1245) was converted to an amphibian as the XPBY-5A prototype with a retractable nosewheel undercarriage and first flown on 22 November, 1939.

By 1939, more advanced flying-boats were being tested including Consolidated's four-engine XPB2Y-1 and the twin-engined Model 31, and the outlook for further contracts for the obsolescent PBY appeared to be poor. However, the start of war in Europe in September brought an immediate urgency for a proven design for the Navy's Neutrality Patrol. On 20 December, two hundred PBY-5s (Model 28-5) were ordered, the largest Navy contract since the First World War. The PBY-5 incorporated the modifications tested on the three PBY-4s with 1,200hp R-1830-82 engines and a change to 0.50in guns for the waist positions. With the versatility of the amphibious version established, the last thirty-three of this order were com-



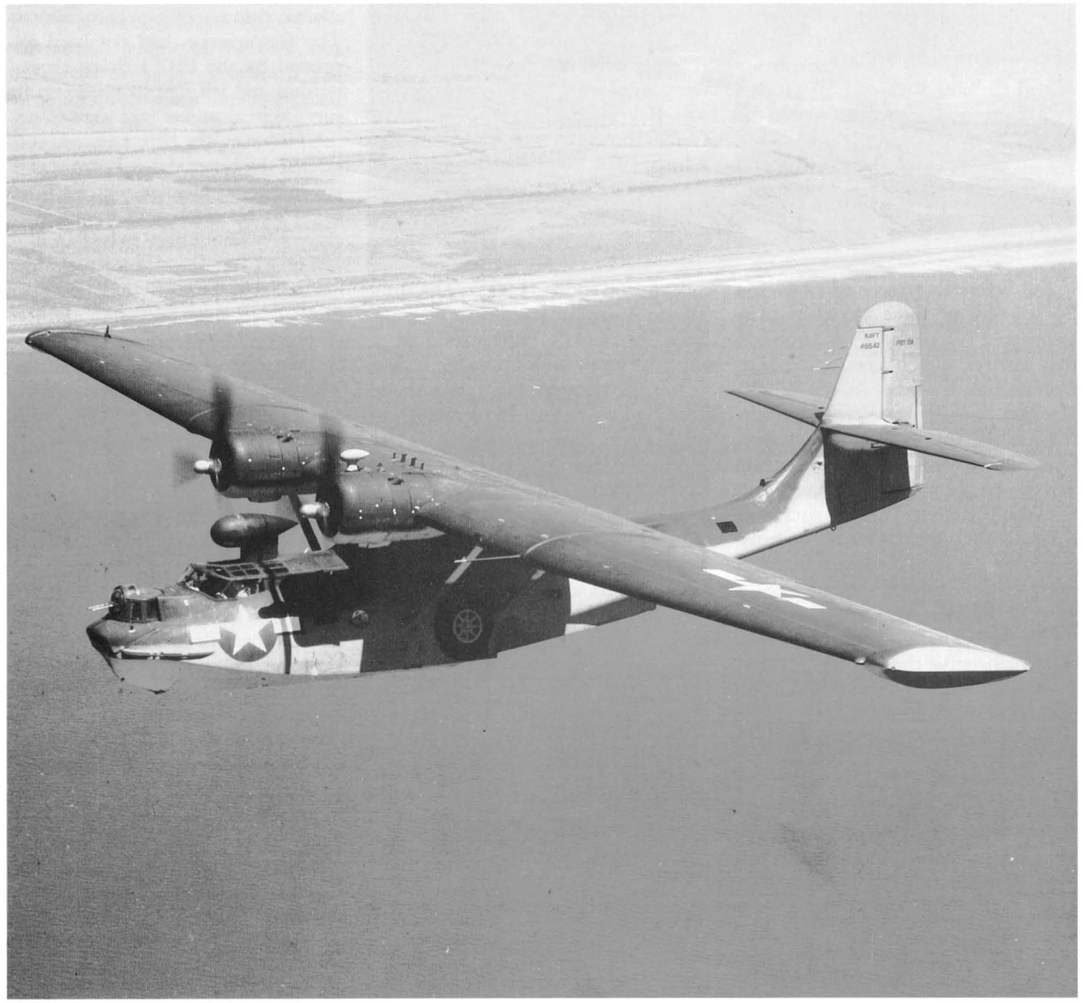
USAF Canadair-built OA-10A 44-33924 photographed in 1948. (Cmdr Jess Barrow collection)

US Navy PBY-6A-NO 46642. (Convair)

pleted as PBY-5As (Model 28-5A) with 1,050hp R-1860-92 engines.

Operations started out of Argentia, Newfoundland, in May 1941 (VP-52) and from Iceland in August (VP-73) and PBY-5s also replaced the -2s of VP-54 based in Bermuda. Airborne search radar had been installed on a PBY-2 early in 1941 and by July, British ASV radar was carried by a single PBY-5 from VP-71, -72, and -73. Pearl Harbor was home to seven squadrons of PBY-2s and -5s when it was attacked on 7 December, 1941. Most of these were lost but one engaged a Japanese midget submarine just before the raid. In the Philippines, Patrol Wing 10 with PBY-4s made bombing raids before fleeing to the East Indies.

The RAF was also in desperate need of an Atlantic patrol aircraft and placed an order for thirty, later fifty, Model 28-5MEs. These had R-1830-S1C3-G engines, an extra two waist guns, armour protection for the eight-man crew, and self-sealing fuel tanks. The name Catalina was designated by the

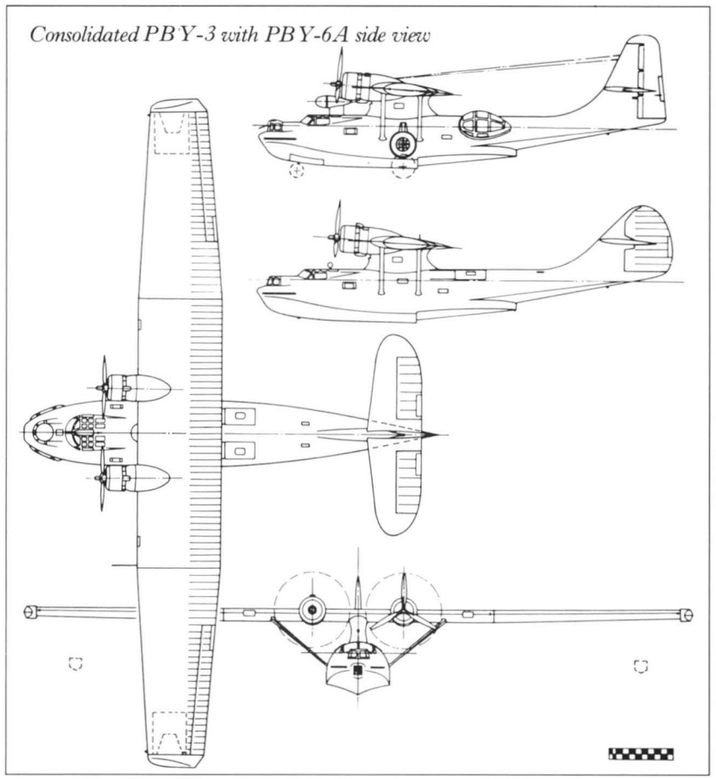


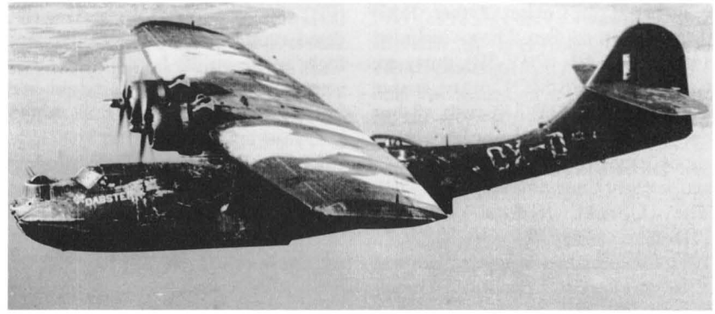
RAF (and later officially adopted by the US Navy). Further orders were placed for another nine aircraft in December 1940 and the RAF also took over the French order for thirty Model 28-MFs in June 1940. All but seven were delivered as Catalina Is, the others, taken over from an Australian order for Model 28-5MAs, as Catalina IIs. The first was received by No.240 Squadron RAF in March 1941 at Stranraer in Scotland, followed by No.209 at Castle Archdale in Ulster. A Catalina from the latter unit found the German battleship *Bismarck*, after she had sunk *HMS Hood*, in the Atlantic on 26 May. This sighting eventually led to the ship's destruction by the Royal Navy.

Other orders for Catalinas were also placed by Australia (eighteen Model 28-5MAs to replace an earlier order), the Netherlands (thirty-six Model 28-5MNs for the Netherlands East Indies Air Force), and Canada (thirty-six Model 28-5MCs and fourteen Model 28-5AMCs). Because of equipment differences, the Canadian aircraft were named Canso and Canso A (PBY-5A), after the original choice of Convoy had been discarded to prevent confusion.

After the United States entered the war, the San Diego factory continued production of 666 PBY-5s, 710 PBY-5As and 145 PBY-5Bs up to

Consolidated PBY-3 with PBY-6A side view





RAAF PBY-5A(M) 'Black Cat' A24-64 OX-D The Dabster. (via Geoff Goodall)

PBY-5A 46573 in Morocco with Flotille 8F in 1944. (ECPA-Marine)

A PBY-5A of No.2 Squadron, Argentine Navy. (Stephen J Hudek collection)

March 1944 for the Navy and Defense Aid (lend-lease) for the RAF and other allied air forces. One other foreign order was for twelve Model 28-5AMNs (PBY-5As) delivered in 1942 for No.321 Squadron, a Dutch unit based in Ceylon. Other RAF deliveries from San Diego included 145 Catalina IBs (PBY-5B), thirty-six Catalina IIAs (28-MC Cansos), twelve Catalina IIIs (PBY-5A) with all but one used for North Atlantic ferry operations, eleven Catalina IVs (PBY-5A), and seventy Catalina IVAs (PBY-5B). The USAAF received fifty-four PBY-5As, designated OA-10, from 1942 for specialised rescue squadrons.

In an effort to improve the handling qualities of the Catalina, the Navy proposed a list of changes that if adopted would have caused considerable delays on the existing production lines. Therefore, an order placed in 1941 for 155 of the revised aircraft, designated PBN-1 Nomad, was given to the Naval Aircraft Factory, Philadelphia. The PBN-1 had an extended bow and hull afterbody with a small breaker step forward of the tail, revised wingtip floats, additional fuel capacity in a strengthened wing, a taller tail, and a 0.50in gun forward. The first delivery was not made until February 1943 and only seventeen were delivered to the Navy. The remaining 138 were supplied to the USSR under lend-lease but one was lost before handover. The designation Catalina V was reserved for the PBN-1 but not used.

Although Canada had selected the PBY in December 1939, an order was not placed until an arrangement was concluded for Boeing Aircraft of Canada to manufacture the type at Vancouver. The initial production consisted of fifty-five Canso As (PBY-5A) assembled from Consolidated-supplied parts, with the first flight made on 26 July, 1942. These were followed by two hundred and forty PB2B-1s (PBY-5) built under lend-lease and first flown on 31 March, 1943. The RAF received two hundred as Catalina IVBs and thirty-four of these went to New Zealand and seven to Australia. These were followed by sixty-seven PB2B-2 (Model 28-6) Catalina VIs with the PBN-type tail and revised radar. Of this batch, forty-seven went to the RAAF and six to the USAAF.

A second Canadian production line was established by Canadian Vickers (Canadair Ltd from November 1944) at St Hubert then Cartierville, Montreal. Deliveries started in April 1943 with one hundred and thirty-nine Canso As for the RCAF, followed by two hundred and thirty PBV-1As (PBY-5A) for the US Navy. However, all the latter were delivered to the USAAF as OA-10As.

Originally built to produce the P4Y-1 (Model 31), the Consolidated Vultee factory at New Orleans was turned over to Catalina production in July 1943 when Wright R-3350 engine supplies were diverted to the Boeing B-29 programme. The first aircraft completed was a sole PBY-5 in April 1944, followed by fifty-nine PBY-5As. Finally, one hundred and seventy-five PBY-6As (Model 28-6A) with PBN tail, two 0.50in guns in the bow turret, and radar mounted above the cockpit were built. The USAAF received seventy-five as OA-10Bs and forty-eight went to the USSR. One used by the Coast Guard as a staff transport was designated PBY-6AG.

Final North American production totals were San Diego, 2,159; New Orleans, 235; Philadelphia, 155; Vancouver, 362; and Montreal, 369. Including the Buffalo-built prototype, a total of 3,281 Catalinas were built, of which 1,428 were amphibians.

In the Pacific theatre, US Navy Catalinas saw widespread use throughout the campaign. Early experience confirmed the British doubts of vulnerability to fighter attack and tactics were changed. One of the most successful operations from 1942 until the end of the war was the 'Black Cat' night search and attack role, first refined by VP-12 from Guadalcanal in the Solomon Islands. In contrast, some of the world's worst weather was experienced by Catalina crews in the Aleutian Islands. Undoubtedly the most respected task, at least by other airmen, was that of 'Dumbo' rescue missions undertaken everywhere.

Over the Atlantic, the primary goal was to find U-boats and between

August 1942 and July 1943, fourteen were sunk by Navy PBYs, including two off the coast of Brazil. The first squadron to be fitted with Magnetic Airborne Detector equipment (as the 'MAD Cats') was VP-63 who supported the Allied landings in North Africa (Operation Torch) and sank three U-boats in the Strait of Gibraltar. A 'one-off' transport conversion was the PBY-5R, lacking a nose turret and with cabin windows. One squadron, VP-6, was formed at Argentina with Coast Guard personnel and by the end of the war the US Coast Guard had acquired 114 Catalinas. Most were quickly retired after 1946, but some remained in service until April 1954. The same fate awaited the Navy 'boats, by 1948 only five remained in the Fleet. However, a few were retained by reserve units and the last Navy aircraft (a PBY-6A) was retired at Atlanta, Georgia, on 3 January, 1957. USAF survivors were redesignated A-10A and A-10B in 1948 and continued in the ASR role until completely replaced by Grumman SA-16s in January 1953.

Apart from the United States, the largest wartime user of the Catalina was the RAF. As aircraft were frequently seconded to other Commonwealth air forces, exact figures are difficult to pinpoint. However, of the 602 assigned, at least 578 served with twenty-one squadrons including No. 333 (Norwegian), Nos.413 and 422 (RCAF), No.490 (RNZAF) and No.262 which became No.35 South African Air Force. Catalinas served in the Far East, East and West Africa, and the Indian Ocean besides the North Atlantic. Patrols were also flown to Lake Lachla, near Archangel, to support convoys en route to the Soviet Union. After the war, the Catalina was swiftly withdrawn and most scrapped on site.

Canada received 217 aircraft and Catalina Is entered service with No. 116 Squadron in 1941. No less than five U-boats were sunk by No.162 Squadron within two months in 1944, one action resulting in a posthumous VC to Flt Lt D E Hornell. The other Catalina VC was awarded to F/O J A Cruikshank of 210 Squadron, RAF. With the RCAF, the Canso A continued in service until April 1962, as freighters, aerial mapping platforms, and finally for ASR duties.

Australia had a total of 168 aircraft from various sources for five squadrons plus ASR Flights. They were operated in the Solomons and in the New Guinea campaign on Black Cat operations coded 'Milk Run' and conducted extensive mining, particularly effective against Balikpapan-bound oil tankers. Some RAAF PBY-5As had the wheels removed to increase their range and were redesignated PBY-5A(M). New Zealand received fourteen PBY-5s and eight Catalina IVAs from April to October, 1943, and thirty-four PB2B-1s in 1944 for Nos.5 and 6 Squadrons, used mostly for ASR work in the Solomons. Post-war, they were used in the South Pacific until replaced by Sunderlands in 1953.

The Dutch supplemented their original deliveries with thirty-three aircraft from the RAF, RCAF, USN, and RAAF and these continued to serve in the East Indies until 1958.

France apparently placed an order for PBYs in late 1939 to equip Escadrille 10E, but these were never delivered. Two French units were formed and trained in the USA with around twenty-eight PBYs acquired under lend-lease from 1943, one a Free French squadron, the other comprised of ex-Vichy France supporters now anti-German. Both were under the control of the US Navy and flew patrols from Morocco. After the war, twenty of the aircraft were purchased and joined by two ex-USAAF OA-10As in 1947. The PBYs saw action in the Indo-China theatre, and later in the Algerian campaign. The last two were withdrawn in 1958.

Six years later, four PBY-5As were acquired from Timmins Aviation in Canada and based at Papeete, Tahiti, from April 1965 in support of the Nuclear Test Range. Joined by a fifth PBY (incredibly once a French wartime aircraft) the fleet transported some 15,000 passengers plus freight until the unit was disbanded in December 1971. Brazil received seven PBY-5s and fifteen PBY-5As from January 1943 to support US Navy PBYs based at Natal and were credited with the sinking of

PBY-5A Canso C-FCRP (msn CV-271) operated as a tanker by the Province of Newfoundland at Gander in July 1975. (Karl Krämer)

PBY-6A N6458C operated as a firefighter tanker by Hermet Valley Flying Service, California. (Steve Nation)

the U-199 in July 1943. Subsequently, twenty-eight PBY-5As (designated by the FAB as CA-10, later CA-10A and C-10A) and two PBY-5s were used by the 2nd Aviation Group, Belém. Amazon River services continued until the last PBY-5A was retired in June 1982, certainly the final military operation with a Catalina.

The only other military wartime user of the Catalina was Chile, with three PBY-5s delivered from 31 March 1943. Six PBY-5As and six OA-10As were received in 1947; one (405) operated the first flight to Isla de Pascua (Easter Island), on 19-20 January, 1951. They were replaced by Grumman SA-16s in the mid-1960s.

Postwar, the Catalina saw military service in at least sixteen other countries as follows.

Argentina: One civil aircraft purchased in 1946 followed by fifteen ex-RCAF Canso As in 1947-49 for use by 2 Squadron at Comandante Espora and 3 Squadron at Punta del Indio. Saw service during the 1955 revolution, but disbanded in April 1960 when replaced by Lockheed P2V-5 Neptunes. Two continued with the General Purpose Squadron, one until 1971.

China (Nationalist): Three were in service at Sung Shan AB in 1966 for supply missions to offshore islands. As they were regularly fired upon, this was probably the last Service deployment of a PBY.

Colombia: Thirteen ex-USAF OA-10As were supplied in 1946, based at Cartagena for Caribbean and Pacific patrols. At least two were converted to transports and used by SATENA.

Cuba: Six PBY-5As supplied in 1947, some still in service in 1958.

Denmark: Eight ex-RCAF PBY-5As were received between 1947 and 1951, replaced by eight PBY-6As in 1957 for Greenland and Baltic patrols. Three were lost in 1963 and 722 Esk received replacement Sikorsky S-61s; the last military Catalinas in Europe were retired in 1971.

Dominican Republic: Four PBY-5As supplied in the mid-1960s, in use until 1979.

Ecuador: Three PBY-5As were used by TAM for services to the Galapagos Islands.

Indonesia: One aircraft (RI-005 ex-VH-BDP) was flown on weapon-supply missions but crashed in Dec-ember 1948. Another was captured from the Dutch and others handed over in June 1950.

Israel: Two were used for ASR missions from Haifa from 1953.

Japan: Two PBY-6As were in service from 1954.

Mexico: Five PBY-5As were acquired in 1947, at least one (MT-03) converted as a transport.

Paraguay: One PBY-5A for presidential use, used in 1955 by Peron to leave Argentina for exile, withdrawn by 1983.

Peru: Three PBY-5As and three OA-10As, based at Callao. Four were used as transports by TAM from 1959.

Sweden: Three entered service as type Tp 47s with F2, later transferred to F8. One (47002) was shot down by a Soviet MiG-15 over the Baltic on 16 June, 1952; one is preserved.

No less extensive was the airline use of the Catalina which had started with American Export Airlines in 1939. In December 1940, BOAC received the second *Guba*, now registered G-AGBJ, and introduced on the United Kingdom — Lagos service the following March. Two other BOAC Catalinas were flown to RAF Koggala Lake, Ceylon, for trans-Indian Ocean flights to Australia. The first proving flight left on 3 November, 1942, for the Swan River, Perth, with an RAF crew, followed by the first operational one made by a QANTAS crew on 10-11 July, 1943, with G-AGFM *Altair Star*. Three more Catalina IVs were acquired and 271 flights were made until 18 July, 1945. With a crew of six and extra fuel tanks in the hull, only three passengers and mail could be carried on the 'Double Sunrise' 28-31hr flight even with a take-off overload of four tons. The service was operated in complete radio silence and in 1949, Capts R B Tapp, L R Ambrose, and W H Crowther were awarded the Johnson Memorial Trophy in recognition of this feat of navigational skill.

QANTAS had other long-range flying experience, many of its crews had ferried PBYs from San Diego to Australia. After the war, seven modified PB2B-2s were put into service starting with the Sydney—Lord Howe Island route in December 1947. The following year, flights to Espiritu Santo via Noumea were added and in May 1949, three aircraft began to operate out of Port Moresby, New Guinea. The last was retired in 1958. In order to prove the feasibility of airline service from Australia to Chile, Capt Gordon

The sole four-engined conversion of the PBY, the Bird Innovator at Long Beach, California. (John Wegg)

Taylor made a record-breaking survey flight in 1950 using *Frigate Bird II*. Taylor was familiar with the work and the Catalina. His first *Frigate Bird* had been an RAAF aircraft flown to Australia from Mexico in 1944, and he had crewed the *Guba* flight to Africa and the first delivery from San Diego to Rose Bay, Sydney. Other Australian airline users included Trans-Australia Airlines and W R Carpenter Airlines.

Catalinas were also used in the Pacific by the French airlines RAI and TRAPAS, and by the New Zealand TEAL, although the latter was only used to survey the 'Coral Route'.

In the Far East, airline operators included Cathay Pacific Airways (one aircraft suffered a fatal hijack on 16 July, 1948), Macau Air Transport, CAT, Thai Airways, Union of Burma Airways, KLM/KNILM, and Garuda Indonesian Airways. In the United States airline use was mostly restricted to charter operators, except in Alaska where scheduled services were flown by Ellis Airlines, and in the Caribbean, by Antilles Air Boats.

Bahamas Airways was a brief user, as were Air France, Flugfelag Islands and Loftleidir. Over a dozen Canadian airlines put them into service, as did Panair do Brasil and Cruzeiro do Sul. In Chile, Aeroservicios Parrague pioneered service to Easter Island and Tahiti and still used one for regular passenger flights from Santiago to Los Cerrillos in 1983, probably the last such operation in the world. Passenger layouts varied considerably between each aircraft, but usually there were no more than twenty-two seats.

Although slow, the Catalina was still one of the most efficient amphibians available after the war and many were converted for civil use as luxury air yachts, cargo carriers, insect sprayers, and for oil and mineral exploration, the last with various antennae and MAD tails. In the USA, the PBY-5A was awarded Type Certificate 785 in 1947 as the Model 28-5ACF. Modifications nearly always included the replacement of the forward gun turret with a clipper bow and relocation of the engineer's controls to the cockpit for two-crew operation. Otherwise, work differed widely. Some blisters were removed; cargo and passenger doors (including ventral stairways), decks, diving platforms, and lifeboats were added; and extra windows installed. The best known postwar Catalina was the PBY-6A *Flying Calypso* operated by the Cousteau Society until its fatal crash in July 1979. One of the most obscure was the Dominican-registered aircraft, converted into a communications centre by Southern Air Transport at Miami, and used under the code name *Swan Island* by the CIA during the Bay of Pigs incident in 1961.

Steward-Davis of Long Beach, California, was probably the largest producer of conversions and also introduced the Super Cat, powered by 1,700hp Wright Cyclone R-2600s taken from surplus North American B-25s. Many of these also received a squared-off tail to aid stability. Steward-Davis also offered the Skybarge in 1965 with two large cargo doors, a detachable cargo hoist and the option of a jet engine mounted over the wing. None were built.

The most long-lasting of all the Catalina's roles has been that of fire fighting. A PBY-6A was converted in California in 1957 with two 750US gal capacity tank and twin doors in the hull for each tank to scoop up water. However, water is a precious commodity in the western United States and borate was preferred which led to heavier aircraft being more suited to the task of aerial tanker.

Field Aviation of Toronto introduced a water scooper conversion in 1961 and by 1968, twenty-eight conversions had been made. Others were similarly converted in Canada, the United States, and France by other concerns, for provincial use and for the Protection Civile based at Marseilles-Marignane. A 960US gal tank could be filled in 14 seconds by using a retractable probe in the hull. A record was set in June 1964 when a PBY-5A dropped 112,320 gallons of water in one day and on several occasions more than 20 loads per hour, and 120 loads per day were recorded. Field also proposed a Rolls-

Royce Dart-powered version in 1966, but despite renewed interest in such a modification over the years, none have been completed.

The Innovator, converted by the Bird Corporation, Palm Springs, California, in 1968, was an attempt to rectify the lack of power and increase the range without loss of speed. Two 340hp Lycoming GSO-480s with reversible Hartzell propellers were added outboard of the wing struts to make a four-engined Catalina. Although successfuly used by Bird — the world's largest manufacturer of medical respirators — it remains a unique conversion.

Today, around one hundred Catalinas exist, many preserved in museums. However, some twenty are still working in Canada as fire fighters with the Provinces of Quebec, Newfoundland, and Saskatchewan, and with The Flying Fireman. One of the last's aircraft is operated under contract in Norway. With a low annual utilisation (around 200hr) and freshwater operations, it is estimated that the Catalinas could remain in service well into the next century.

The XPB2Y-1 in its original configuration in 1937. (Convair)

PBY-2

Two 900hp Pratt & Whitney Twin Wasp R-1830-64 fourteen-cylinder air-cooled radial engines.

Crew: 7-9

Armament: Four 0.30in machine-guns (or two 0.50in and two 0.30in), four 325lb depth charges, four 500lb bombs, two 1,000lb bombs, or two 2,167lb Mark XIII torpedoes.

Span 104ft 0in; length 65ft 2in; height 18ft 6in; wing area 1,400sq ft.

Weight empty 14,568lb; gross weight 28,640lb.

Maximum speed 178mph at 8,000ft; cruising speed 105mph; climb 860ft/min; service ceiling 21,100ft; maximum patrol range 2,131miles (1,750US gal fuel capacity).

PBY-5A

Two 1,200hp Pratt & Whitney Wasp R-1830-92 fourteen-cylinder air-cooled radial engines.

Crew: 7-9

Armament: Two 0.50in and two 0.30in guns, remainder as PBY-2.

Length 63ft 10in; height 20ft 2in (otherwise as PBY-2).

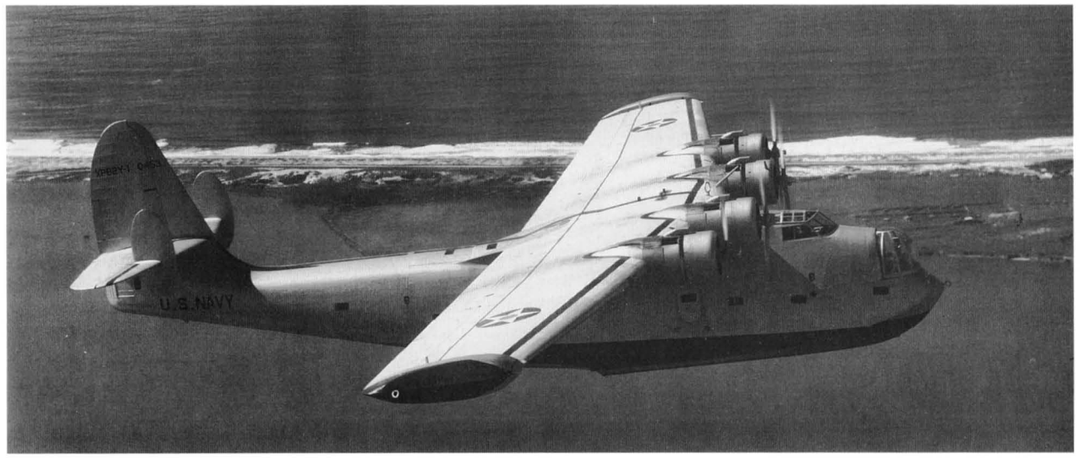
Weight empty 20,910lb; gross weight 35,300lb.

Maximum speed 179mph at 7,000ft; cruising speed 117mph; climb 10,000ft/19.3min; maximum patrol range 2,545miles (1,478US gal fuel capacity).

Model 29 PB2Y Coronado

Less than three months after the first flight of the XP3Y-1 (Model 28), the US Navy held a design competition for a much larger, four-engined flying-boat and awarded prototype contracts to Sikorsky and, on 27 May, 1936, to Consolidated. Laddon's design used the wingtip retractable floats of the XP3Y-1 but featured a deep hull for ten crew and a 115ft span wing. Capable of carrying a six-ton ordnance load, the XPB2Y-1 (BuA 0453) had four 1,050hp Pratt & Whitney XR-1830-72 Twin Wasps, a tall single fin and rudder, and a gross weight of 49,754lb. Provision was made for two 0.50in nose and tail guns in manually-operated turrets and three 0.30in guns in the waist position, one firing downwards through a watertight hatch.

The XPB2Y-1 made its first flight, of 1hr 15min, on 17 December, 1937, with Bill Wheatley and George Newman Jr but immediately there were signs of serious directional instability. In an effort to solve the problem, which had become more prominent on the second and third flights, two elliptical fins were installed, halfway to the tailplane tips, which added 50sq ft of area.



The XPB2Y-1 (0453) after the addition of 'Zulu-shield'-type fins in 1938. (Convair)

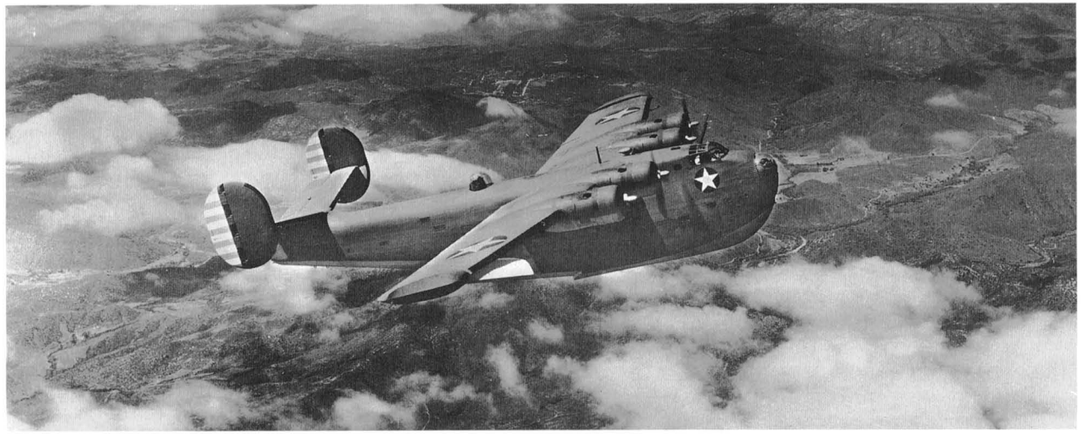
The first PB2Y-2 (1633), one of two used by VP-13 for radio-instrument landing training under the name Project Baker. *(Convair)*

In this form, a fourth flight was made with Wheatley and Sutton on 28 February, 1938, but this modification proved inadequate. Instead, the complete tail was redesigned by Fleet with twin fins and rudder and $7^1/_2$ degrees dihedral on the tailplane. In this configuration, the XPB2Y-1 first flew in July 1938 (its 44th flight) but because of additional changes to the hull, it was not delivered to the Navy until 24 August, 1938, for further trials.

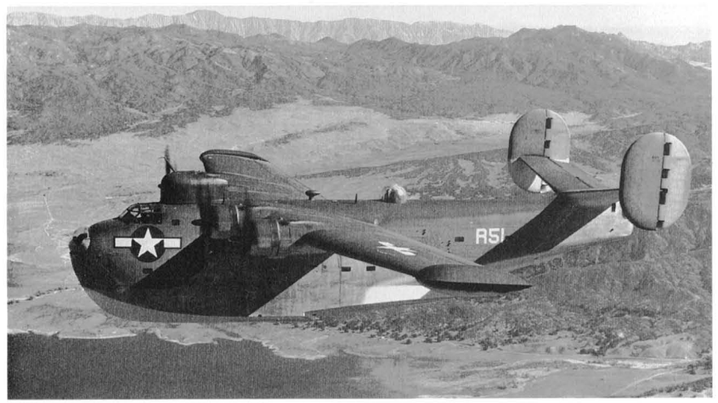
On 27 October, the XPB2Y-1 was flown to NAS Anacostia by Lt-Cdr Andrew Crinkley and ten crew in 13 hours to take part in a review of Army and Navy strength by President Roosevelt, returning to San Diego on 8 November. On 24 August, 1939, it was handed over to Admiral A B Cook, commander of the Aircraft Scouting Force, and used as a VIP transport, the first time that an aircraft had been used as a flagship. Following a visit to Alaska, the prototype, nicknamed the *Blue Goose*, flew for two years in the Pacific, mainly between Hawaii and the USA, carrying 916 passengers including 299 of flag rank. In March 1944, it took Admiral Chester Nimitz to confer with Gen Douglas MacArthur in Brisbane, a visit that resulted in the attack on the Carolines. In August 1945, the *Blue Goose* was flown to NAS North Island, San Diego, and scrapped. Because of the commitment for large numbers of PBYs, the first order was not received until 31 March, 1939, for only six PB2Y-2s (BuA 1633/1638) powered by uprated R-1830-78s with two-stage superchargers, four-bladed propellers inboard and three-bladed outboard, deeper hull, more elliptical vertical fins similar to those of the B-24, and increased armament of six 0.50in guns in three turrets. First flown on 22 November, 1940, de-liveries began on 31 December to VP-13 for experimental purposes as they lacked self-sealing fuel tanks and armour protection for the nine crew. Poor 'skipping' characteristics were reported for the type although this was alleviated to some extent by the addition of a ventilation step on later production aircraft. The Coronado also had a tendency to swing on take-off and was heavy on the controls.

The last PB2Y-2 (BuA 1638) was delivered as the XPB2Y-3 in December 1941, with R-1830-88 engines, self-sealing fuel tanks, eight 0.50in guns, and 2,000lb of armour for the crew. This variant had already been ordered into production as the PB2Y-3 on 19 November, 1940, and 200 were delivered (BuA 7043/7242) between June 1942 and October 1943. With the considerable increases in weight, the PB2Y-3 was seriously underpowered and the subject of early Navy tests with Jet-Assisted Take Off (JATO) rockets. Often ASV radar was carried in a radome behind the cockpit but apart from taking part in the bombing of the Marshall Islands, there was little operational use.

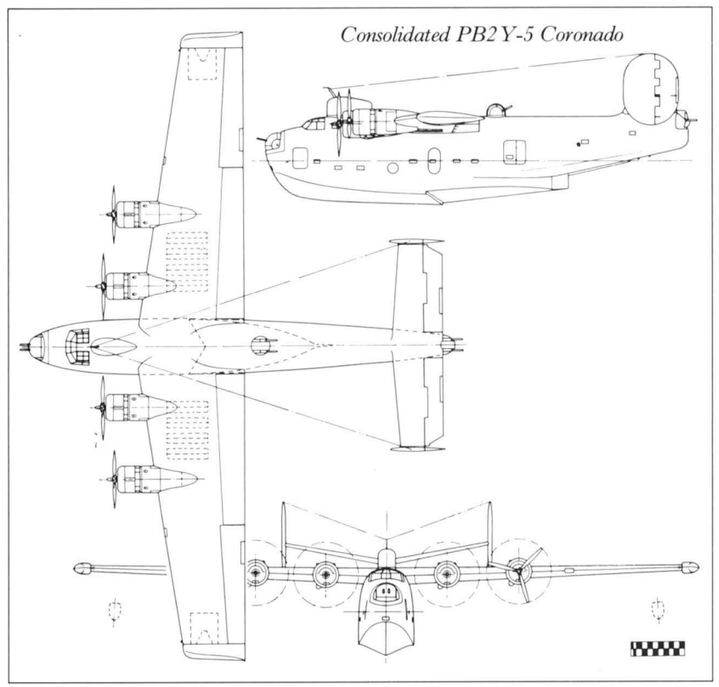
Under lend-lease, thirty-two aircraft (designated PB2Y-3B) were



An early production PB2Y-3 with revised mid-upper gun position. (Convair)



PB2Y-5 7179 with ASV radar mounted behind the cockpit. (Consolidated)



diverted to the RAF as Coronado GR.Is (JX470/501) and this name came into general usage in the US Navy as well. However, only ten were actually delivered to the RAF. The first was JX470 on 16 April, 1943, but instead of going to Coastal Command, all were passed to No.231 Squadron, Transport Command in September 1944. Based at Montréal they were used for transatlantic freight services to Lagos in Nigeria and Largs in Scotland. Transferred to Bermuda in September 1945, they remained in service until the following January. Not returned to the USA, the four survivors were scuttled on 28 March, 1946. Three were loaned to BOAC (JX471/495/496) for evaluation from June 1943 (471), October 1943 (495) and March 1944 (496) for a few weeks each only.

Rohr Aircraft of Chula Vista, California (a few miles south of Consolidated's plant) converted thirty-one to PB2Y-3R transports for NATS from 1945 with R-1830-92 single-stage low-altitude engines, turrets faired over, a side-loading hatch, crew of five, re-routed control runs, and provision for forty-four passenger seats or up to 16,000lb of cargo. Ten aircraft (BuA 02737/02746) were built as such (originally assigned the designation JRY-1). Some were flown by Pan American Airways' crews.

The XPB2Y-4 was a PB2Y-2 (BuA 1636) re-engined with 1,600hp Wright R-2600 Double Cyclones but it remained a prototype conversion only, and the XPB2Y-3 was subsequently redesignated XPB2Y-6.

A number of PB2Y-3s were modified as PB2Y-5s with R-1830-92s, new nose and upper turrets, increased fuel capacity from 1,904US gal to 3,027US gal, and provision for JATO equipment, mounted three on each side of the waist position. The PB2Y-5R was an unarmed transport version and the PB2Y-5H could carry up to twenty-five stretchers. Both versions, also converted by Rohr, were used by VR-2 for flights across the Pacific to the Philippines and were used to evacuate casualties at Iwo Jima. A few were also used as administrative transports designated PB2Y-5F, later PB2Y-5Z. A twin-engined version, known internally as the BM-13, with Wright R-3350-B engines remained a 1940 project.

All PB2Ys were withdrawn from active use before the end of 1945. A Limited Type Certificate (LTC- 5-2) was issued 19 February, 1947, to Robert M Lewis for the PB2Y-3, -3R,-5,-5R,-5Z with R-1830-88,-92, -94, or -82 engines and a gross weight of 66,000lb, but only two aircraft appear to have entered the US civil register. One PB2Y-5Z (msn 57/N69003 ex-BuA 7099) was registered to the Hughes Tool Co and after many years of storage at Long Beach, California has been preserved by the Naval Air Museum at Pensacola.

PB2Y-3

Four 1,200hp Pratt & Whitney Twin Wasp R-1830-88 eighteen-cylinder air-cooled radial engines.

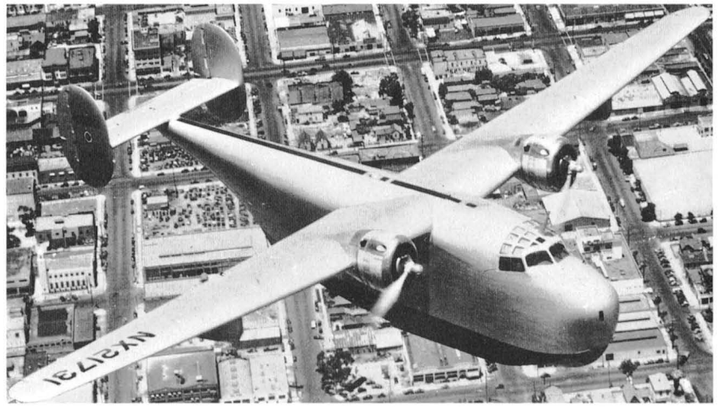
Crew: 10

Armament: Twin 0.50in machine-guns in bow, dorsal, and tail turrets and one 0.50in gun in each of two beam positions plus up to eight 1,000lb bombs, depth charges or Mark 15 or Mark 1302 torpedoes internally and up to four 1,000lb bombs carried externally.

Span 115ft 0in; length 79ft 3in; height 27ft 6in; wing area 1,780sq ft.

Weight empty 41,031lb; gross weight 68,000lb.

Maximum speed 224mph at 19,500ft; cruising speed 140mph; initial climb 550ft/min, 10,000ft/21.5 min; ceiling 20,900ft, maximum patrol range 2,310miles.



The Model 31 pioneered the use of the Davis wing. (Stephen J Hudek collection)

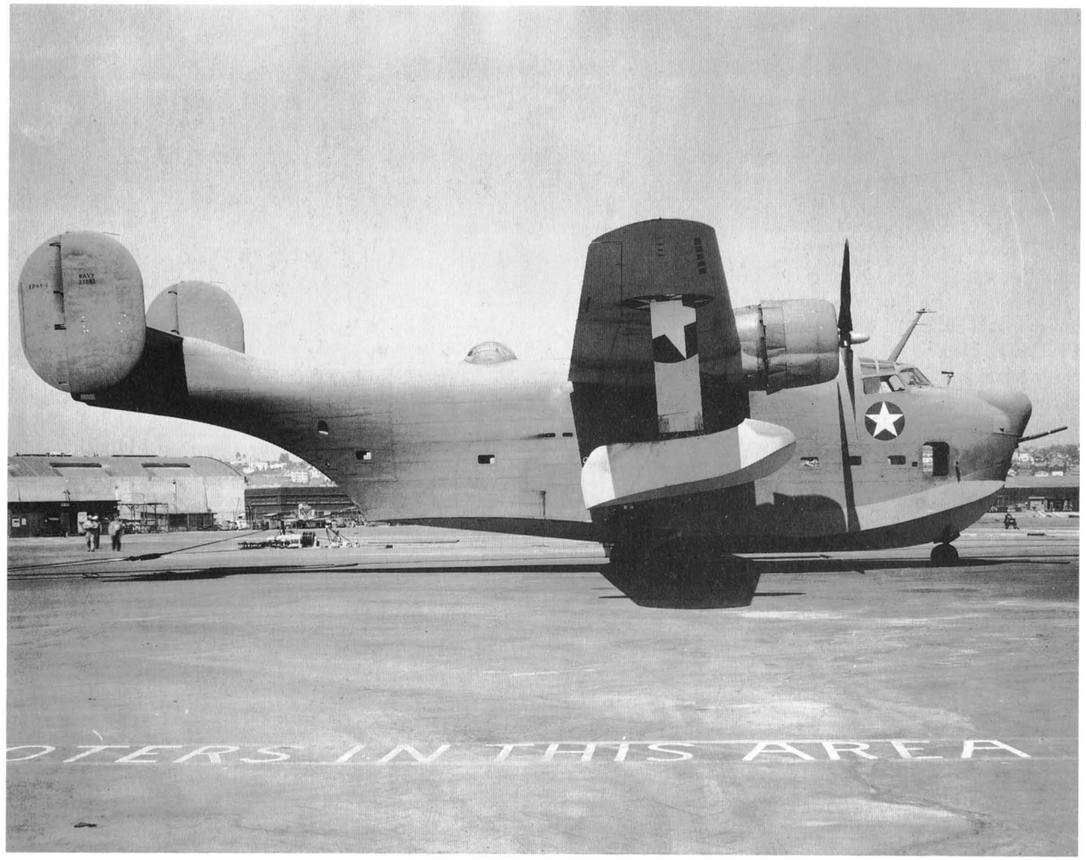
Model 31 P4Y Corregidor

Early in 1938, Fleet and Laddon had drawn up conceptual designs of a twin-engined flying-boat, superior to the PBY and the four-engined PB2-1. Various engines were proposed but the choice was made for the most powerful engine then available, the 2,000hp Wright R-3350 Duplex-Cyclone twin-row eighteen-cylinder radial. The Model 31 was to combine a high cruising speed and a large payload and be suitable both for military and commercial use. In the latter role, it was to carry a crew of five and a double-deck cabin would accommodate fifty-two passengers in a daytime configuration or twenty- eight in a sleeper version for trans-oceanic flights. To avoid the problems experienced by the PB2Y-1, a twin-fin tail was adopted. Originally, a conventional removable beaching gear was planned but this was changed early on to a retractable tricycle-type gear that in an emergency could function as a normal undercarriage.

Engineering drawings were at an advanced stage when encouraging results of wind-tunnel tests of a new aerofoil patented by David R Davis became available. This so-called 'Fluid-Foil' was a high aspect ratio (11.56) design that optimised lift distribution at any section along its length, thus minimising induced drag. Without waiting for a formal Navy design competition, Fleet decided to produce the Model 31 as a company-funded venture in order to ascertain whether the advantages of the Davis wing, licenced by Consolidated, would be realised by a full-scale aircraft.

Construction of the all-metal, stressed skin design started in July 1938 and free of interference from Washington, the prototype, registered NX21731, was rolled out at San Diego ten months later. Immediately it was nicknamed 'Pregnant Guppy' because of its novel hull which combined a narrow planing bottom with a 22ft deep body. In order to preserve the qualities of the Davis wing, and reportedly also to preserve the wing for a bomber design, the retractable floats were mounted on the undersurfaces, midway between the engine nacelles and tips. The 110ft span wing included 5,400US gal capacity integral fuel tanks in the centre section and hydraulically-operated Fowler-type flaps. All control surfaces were fabric covered and the 2,300hp R-3350-8s drove 15.5ft, three-bladed Hamilton Standard Hydromatic propellers.

The first flight was made by Bill Wheatley and George Newman Jr on 5 May, 1939, and initial tests confirmed that the new wing would offer a 20 per cent increase in performance. The maximum speed was reported as 250mph and range was expected to exceed 3,500 miles. Although clearly superior to the PBY and Martin PBM, the Navy was unenthusiastic, citing poor hydrodynamic characteristics at high gross weights. Fleet felt that the Navy's lack of interest was due to its lack of involvement in the project. But whatever the reason, orders for the proven PBY had a higher priority as did work on the Model 32 (B-24) bomber.



The prototype Model 31 converted as the XP4Y-1 in 1942. (Convair)

Several armament installations were tested however and in April 1942 the prototype was acquired by the Navy as the XP4Y-1 (BuA 27852). Positions for a four-man crew were installed (there had been no civil interior fitted), together with twin 0.50in turrets in the tail and waist position, and an M-9 37mm cannon in the nose. In addition, 4,000lb of stores were carried internally on carriages which were run out onto the wings inboard of the nacelles on tracks for dropping. A flaired skirt was added to the forward section of the hull, along with an upswept afterbody to carry the tail turret, the beaching gear abandoned to save weight, and 6in larger Curtiss propellers substituted.

In this guise, the XP4Y-1 first flew in July 1942 and 200 production P4Y-1s (BuA 44705/44904) were ordered in October. The government transferred a factory at Lake Pontchartrain, New Orleans, originally intended for the production of Sikorsky VS flying-boats, to Consolidated in January 1943 for this purpose. However, the R-3350 engines were required for Boeing B-29 production and because of the shortages, the order was cancelled. The P4Y designation was revived in 1951 for versions of the PB4Y Privateer still in service.

Many alternative Model 31s were studied. One was a replacement for Archbold's PBY dated August 1938, another a luxury Air Yacht for five crew and six passengers (December 1938). The BM-14 was a bomber with three power turrets and R-2800 engines, proposed in April 1940.

Model 31

Two 2,300hp Wright Duplex-Cyclone R-3350-8 twin-row eighteen-cylinder air-cooled radial engines.

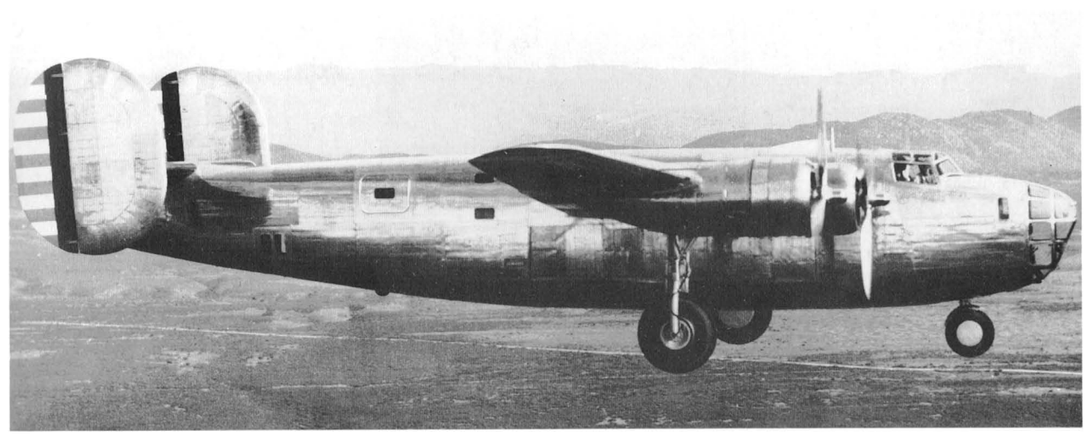
Span 110ft 0in; length 73ft 0in; height 23ft 0in; wing area 1,048sq ft.

Weight empty 26,046lb; gross weight 50,000lb.

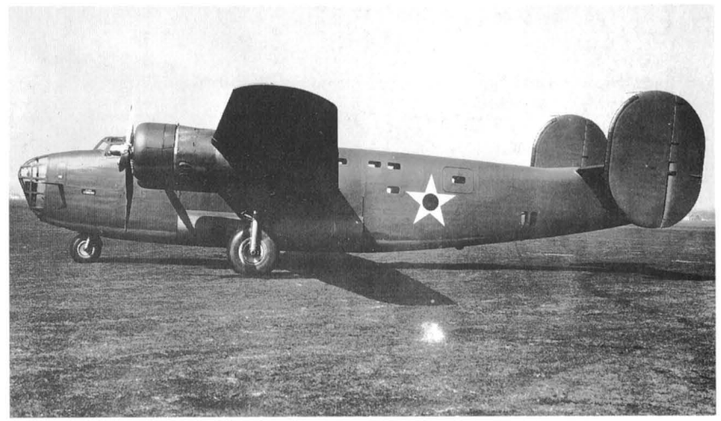
Maximum speed 250mph; cruising speed 160mph; range 3,500 miles (1,655US gal fuel capacity).

Model 32 B-24 Liberator

In January 1939, Fleet and Laddon approached the USAAC with the proposal that Consolidated produce a long-range bomber superior to the Boeing B-17. Earlier, the USAAC had suggested that CAC build the B-17 under licence to provide an additional production line, but CAC personnel returned from an inspection trip to Seattle convinced that a better aircraft could be designed. By the end of January, a mock-up had been built and inspected at San Diego and on 1 February, the USAAC issued Type Specification C-212, a formality as the two companies solicited for proposals, Martin and Sikorsky, only had three weeks to respond. Therefore, on 21 February the Model 32 was recommended for approval and a contract for a single prototype , designated XB-24 (39-556) and to be completed by 30 December, was signed on 30 March.



The XB-24 (39-556) on an early test flight east of San Diego. (A R Krieger collection)



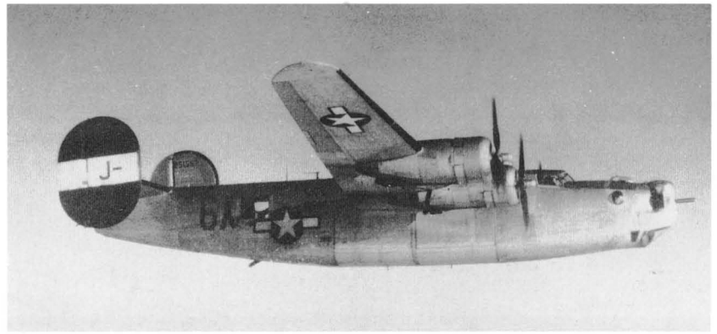
RB-24 40-702, the only YB-24 received by the USAAF. (Wright Field)

This was followed by orders for seven YB-24s in April and thirty-eight B-24As in August. Progress had to be remarkably swift, wing and fuselage mating occurred on 26 October and on 29 December, 1939, the prototype made its first flight from San Diego in the hands of Bill Wheatley and George Newman, together with flight engineers Jack Kline and Bob Keith. The 17 minute flight was to lead to 18,431 more aircraft, the largest production of any American combat type and the highest number of a bomber aircraft ever.

The speed of development was made possible by the Model 31. The flying-boat's Davis wing with hydraulic flaps and the twin tail was adopted for the bomber and the nose-wheel undercarriage, a first for a heavy bomber was in part adopted from the beaching gear of the Model 31. Two deep bomb bays could carry eight 1,100lb bombs, twice the capacity of the B-17, and six hand-held 0.30in guns were carried in the nose, waist, dorsal, ventral, and tail positions. Power was provided by four 1,200hp Pratt & Whitney Twin Wasp R-1830-33s enclosed in PBY-type nacelles. Laddon shared the credit for the rapid pace of design and construction with the USAAC, which had allowed Consolidated to proceed unhindered.

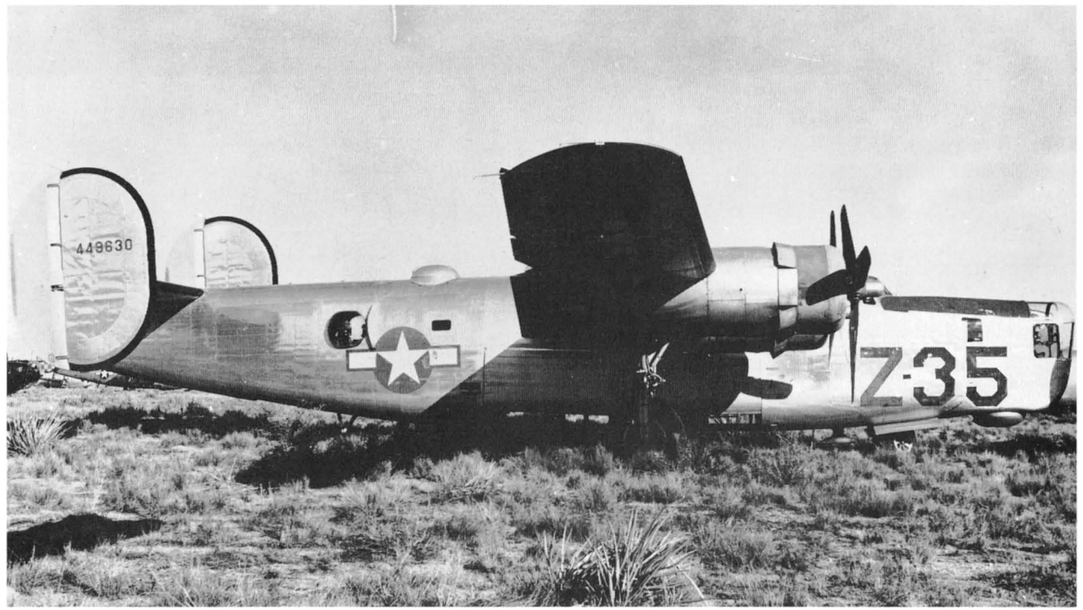
Because of a shortfall in maximum speed, the USAAC had specified turbosupercharged R-1830-41 engines for production aircraft. These, plus self-sealing tanks and protective armour for the crew, were incorporated into the XB-24 which, redesignated XB-24B (and reserialled 39-680), was accepted by the Army on 13 August, 1940. Meanwhile, in April 1940, the French Purchasing Commission had ordered 175 of an export version, the LB-30MF (Mission Français), the designation arrived at by using the next number in CAC's 'Land Bomber' project series. When Britain took over 135 aircraft on 17 June, the name Liberator, already assigned by Consolidated, was used together with the designation LB-30. Self-sealing fuel tanks, armour, and tail and dorsal power-operated turrets were specified by the RAF. Reluctant to wait until USAAC deliveries had been made, the RAF took twenty-six of the early B-24s in exchange for a similar number of LB-30s. The first six were YB-24s (designated LB-30As) with the addition of de-icers but no wing slots and without self-sealing tanks and they went into the North Atlantic Return Ferry Service. Transatlantic flights between Montreal (St Hubert) and Blackpool (Squires Gate) began on 4 May, 1941.

Twenty LB-30Bs (B-24A conversions) followed from March 1941 for Coastal Command's No 120 Squadron as Liberator Is. Theses were fitted with radar, six 0.303in guns, and a tray of four or six 20mm guns under the fuselage. The USAAC accepted the remaining YB-24 (fitted with self-sealing tanks and armour) in May 1941, followed by nine B-24As in mid-1941. The latter were used by the new Ferrying Command and operations began on 1 July, 1941, over the North Atlantic, and on 31 August over the South Atlantic. Two B-24s flew the Harriman Mission to Moscow in September, one returning via the Middle East, India, Australia, and the Pacific; the other via Africa and Brazil.



B-24J-5-FO 42-51557 of the 854th BS, 491st BG (green and white tail), 8th Air Force. (A R Krieger)

A TB-24L conversion used for training B-29 crews, parked at Kingman, Arizona, pending scrapping. (Stephen J Hudek collection)



The LB-30 Liberator II incorporated an additional nose section which increased the length by 2ft 7in to 66ft 4in, a mid-upper and tail turret. Fourteen 0.303in guns, and commercial R-1830-S3C4-G engines (R-1830-61) with Curtiss propellers. All other Liberator variants had Hamilton Hydromatic propellers. The 139 aircraft built were intended for RAF Middle East Squadrons, but when the USA entered the war, seventy-five were taken over by the USAAF. On 17 January, 1942, the 7th Bomb Group flew the first USAAF Liberator combat mission from Singosari airfield, Malang, Java. Others were sent to the Canal Zone, Alaska, and Hawaii and eventually twenty-three were returned to the RAF. The best known was AL504 *Commando* used by Winston Churchill.

Nine B-24Cs with tail and upper turrets, R-1830-41s, and self-sealing tanks were delivered from December 1941, but the balance of the original order was produced as B-24Ds with R-1830-43 engines, the first mass-produced variant.

In order to achieve the required production rates, a new plant was built at Lindbergh Field, San Diego, for Consolidated (CO) production and at Fort Worth, Texas, for Consolidated (CF); Willow Run, Michigan, for Ford (FO); Tulsa, Oklahoma, for Douglas (DT); and at Dallas, Texas, for North American (NT). Besides assembly, Ford was also charged with component production for Fort Worth and Tulsa.

The first B-24D was delivered on 22 January, 1942, at San Diego and was followed by 2,871 more from all five factories. Initial production blocks had seven 0.50in guns, bomb load of 8,800 lb and a fuel capacity of 2,364US gal. A Bendix power turret in the belly was incorporated into 179 aircraft and the last ninety-three B-24D-COs had a Sperry Ball turret. Later models had a 3,614US gal fuel capacity and could carry eight 1,600lb bombs. Gross weight, with nine crew, varied from 55,000lb to 64,000lb and all B-24D-DTs had R-1830-65s. This engine was used by 634 Ford-fabricated B-24Es (the 167 B-24E-DTs assembled at Tulsa had the -43), the first accepted at Willow Run on 1 September, 1942. The initial twenty-five B-24G-NTs were similar and the first aircraft began flight testing in January 1943. Because of production delays at Willow Run, caused by the differences between motor car and aircraft manufacturing, the B-24E was obsolescent by the time it was produced and most were relegated for training in the United States although a few did see combat in 1944.

One of the only seven YB-24Ns (45-2057 msn 6912) completed by Ford between May and June 1945 (Stephen J Hudek collection)

Some 160 were modified as gunnery trainers for Boeing B-29 crews and had a General Electric fire control system. The sole XB-24F was a B-24D with a thermal de-icing system tested at NACA Ames Aeronautical Laboratory, Moffett Field, California, in 1942.

In the Pacific theatre, some B-24Ds were fitted with nose turrets to increase protection and this feature, built by Emerson, was incorporated into Ford production aircraft, designated B-24H, from June 1943. The B-24H also had a retractable Sperry ball turret, first introduced on B-24D-CO Block 140 aircraft. The initial batch of B-24Hs had R-1830-43s, later aircraft the R-1830-65, some of which had improved waist fairings. Three factories, Fort Worth, Willow Run, and Tulsa produced 3,100 B-24Hs and North American built 430 B-24Gs. All but the first twenty-five of the latter variant were to a similar standard.

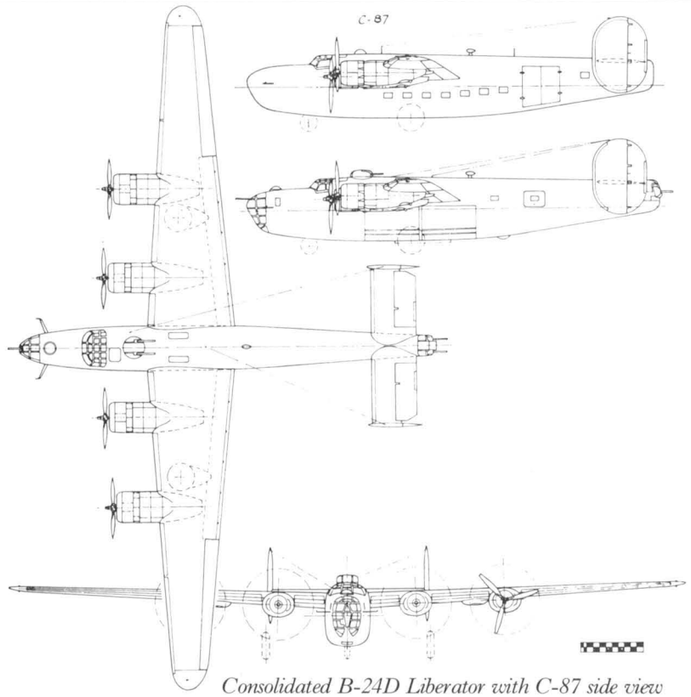
The B-24J introduced at San Diego in August 1943, had a new autopilot and bomb sight and other equipment changes. Put into production at all five plants, 6,678 were built, by far the most numerous model. Many B-24Hs were upgraded to J standard but not redesignated. One B-24H was retained at Willow Run as an XB-24J to serve as a prototype for Ford B-24J production, and another XB-24J was a B-24J-CO fitted with a B-17 nose in an attempt to improve the B-24's forward visibility.

XB-24N-FO 44-48753 (msn 3608). (A R Krieger collection)

A new Consolidated-designed tail position with two hand-held 0.50in guns differentiated the B-24L which entered service in mid-1944. Ford built 1,250 and San Diego completed 417, although only 186 of the latter had the modification. Some of these were also converted as gunnery trainers for B-29 crews. These were followed by 916 B-24M-COs and 1,677 B-24M-FOs with a lightweight Motor Products tail turret, the last Liberator model built in quantity.

One B-24D was modified by Consolidated with a complete tail unit taken from a Douglas B-23. Known as the B-24ST (Single Tail), it was first flown on 6 March, 1943. Following a change to a C-54 tailplane and a new rudder the rear fuselage was attached to another, later production, B-24D (with nose turret and R-1830-65 engines) and designated XB-24K, the 'new' aircraft was first flown on 9 September, 1943. Tests at Eglin revealed that the new tail configuration improved aircraft handling and field of fire for the tail guns and recommended that all future Liberators be so fitted. One XB-24N with a single tail, R-1830-75 engines, ball turret in the nose and modified tail turret was delivered in November 1944 followed by seven YB-24Ns during May and June the following year. But with the end of the war in sight, a further 5,169 B-24Ns had already been cancelled in April.

Because the Liberator was used in every theatre in many different roles, it was impossible to incorporate detail

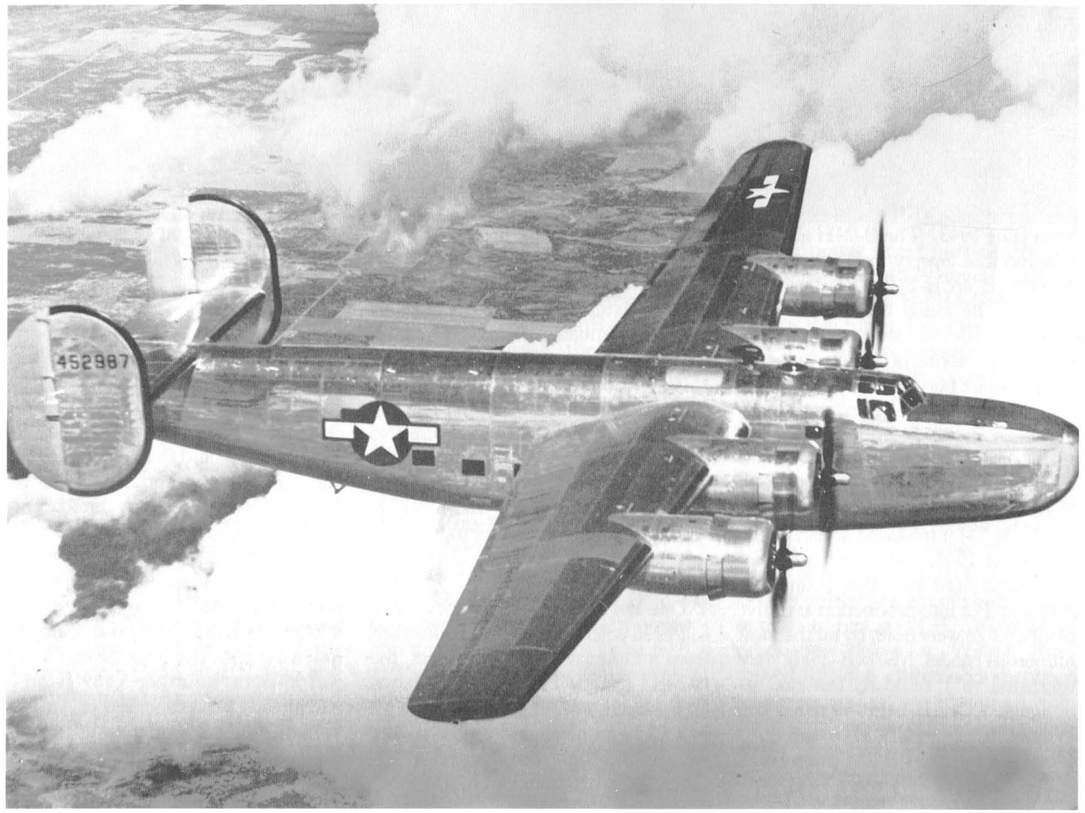


Consolidated B-24D Liberator with C-87 side view

changes particular to an area or mission into aircraft on the production lines. Therefore, Modification Centers were established for this work to where new aircraft were delivered from the manufacturer. By July 1944, B-24s were being produced at such a rate that the Modification Centers could not keep pace and new aircraft had to be delivered to storage pools. Some four hundred B-24s still remained in storage on VJ-Day.

With so large a production run, inevitably there were a host of modifications which changed designations. By 1944, production was established to the extent that new aircraft, rather than ex-operational ones, could be used for training and those so-allocated received the 'T' prefix (TB-24J/L/M). The XB-24P was a B-24D-CO converted by Sperry Gyroscope Co in July 1945 for airborne fire control systems research and the XB-24Q was a B-24L-FO used by General Electric to

The last C-87-CF, 44-52987. (Aero Digest)



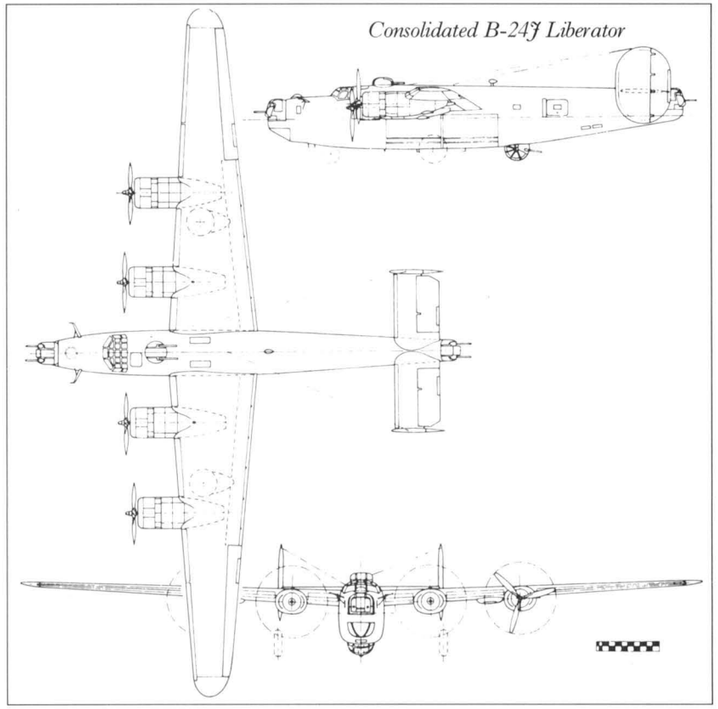
RY-1 NL515N The Explorer *flown by Bill Odom for the Reynolds Boston Expedition to China.* (A R Krieger)

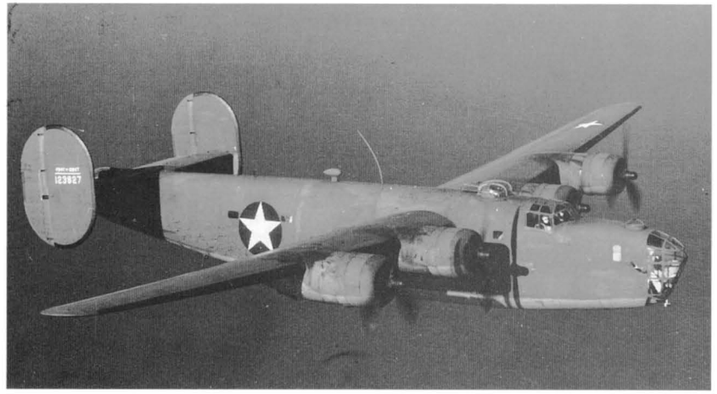
test its new radar-controlled tail turret for the Boeing B-47. Ten SB-24Ds had radar-controlled bomb sights for night attacks against Japanese targets. The BQ-8 was a radio-controlled bomb conversion for use against Japanese-held island targets, but no operational flights took place.

The XF-7 was a fully-armed photographic reconnaissance aircraft with extra fuel converted from a B-24D-CO in January 1943. Eleven cameras were carried in the nose, bomb bay, and tail. Lockheed produced four similar aircraft, designated F-7, with detail changes and additional fuel. A further one hundred B-24Js were fitted with three nose and three bomb bay cameras as F-7As by Northwest Airlines (St Paul), Martin (Omaha) and Consoli-

The last Liberator in service with the USAF in 1953 was EZB-24M-21-FO 44-51228 used for ice research. (A R Krieger)

Consolidated B-24J Liberator





Early conversion of a B-24D-7-CO (41-23827) for the US Navy as a PB4Y-1 (BuA 31937). (US Navy)

dated (Tucson). All but two of one hundred and nine F-7Bs (six bomb bay cameras) were converted from B-24Js, the last pair from B-24Ms.

As the first Liberators had been used as transports, it was logical that a specific version for this task be produced. Designated C-87 and known as the Liberator Express, this had a modified fuselage with twenty-five seats, windows, and a port side loading door. A prototype was completed at San Diego from a crashed B-24D in 1942 and conversions were made on the production line at Fort Worth, with the XC-87 making its first flight on 24 August, 1942, followed by 279 more by August 1944. Five were transferred to the Navy as RY-2s. Six VIP 16-passenger/ten-berth C-87As were also built, three each for the USAAF and Navy (the latter known as RY-1s). One of the USAAF aircraft became the presidential Guess Where II. Some C-87s operating over the 'Hump' had two fixed forward-firing guns but the C-87B, with five 0.50in guns, was not built. Five C-87s were completed as flight engineer trainers, designated AT-22 and later TB-24Ds. They carried a crew of five plus thirteen instructors and pupils. Another twelve B-24s were converted to C-87 standard, including one by Ford which differed in details and was called the Ford Utility Transport. During the latter stages of the war, several B-24s were converted as transports and designated CB-24s.

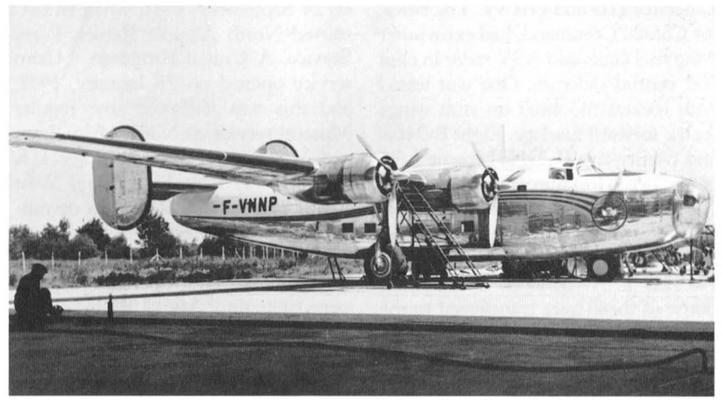
Ford converted a B-24E to the XC-109 in 1943 with an extra 2,036US gal of fuel in eight light alloy tanks for use in the China-Burma-India theatre to ferry gasoline to China-based B-29 units. Ford converted another 199 and Martin nine C-109s from B-24J/L models with flexible instead of metal tanks, an automatic APU shut-off, and a modified fuel systems. After several take-off crashes, the fuselage fuel load was frequently reduced to 1,200US gal. Limited use was made of the C-109 in Europe in 1944.

In 1942, in an attempt to provide a long-range escort for B-24s in Europe, Fort Worth converted a B-24D as the XB-41 with fourteen 0.50in guns. These were mounted in pairs in chin, tail, ventral, port waist, and two dorsal turrets along with two in the starboard waist hatch. Ammunition was carried in the forward bomb bay. In February 1943, trials at Eglin indicated an unsatisfactory centre of gravity location and poor climb and ceiling characteristics and thirteen YB-41s were cancelled. However, the XB-41 was modified with wide-blade propellers and a B-17F chin turret, plus modifications to other turrets and removal of some armour. Returned to Eglin on 28 July, the XB-41's stability problem was cured but the aircraft was unmanoeuvrable. In light of the similarly poor experience with the Boeing XB-40, further work was abandoned in favour of increasing the range of fighters and the aircraft was redesignated as a TB-24D.

Because of its superior range over that of the B-17, the USAAF decided

An RAF Liberator III completed to G.R.V standard with chin-position ASV radar and rocket rails mounted on stub wings on the forward fuselage. (Stephen J Hudek collection)

Civil conversion of an LB-30/C-87 (msn 80 ex-RAF AL 583) for Transportes Aéreos de Panama SA. (Stephen J Hudek collection)



Emperor Bo Dai of Vietnam's Liberator I (msn11) was once RAF AM920. (Jean Delmas collection)

to concentrate the type in the Pacific. But before the first complete B-24 Group, the 90th, was deployed with the Fifth Air Force in October 1942, the B-24 saw action in Europe. A detachment of B-24Ds en route to China was held in Egypt. From there an attack was made on the Ploesti oil fields in Romania on 12 June, then they were used to form the nucleus of the Ninth Air Force. Operations started with the Eighth Air Force from England on 9 October and a year later with the 15th Air Force in Italy. Before the Ninth was moved to England, a heroic unescorted low-level attack was made on Ploesti on 1 August 1943, resulting in heavy losses.

Full-scale Liberator operations in the Pacific began on 16 November, 1943, with an attack on Bougainville and continued in support of the capture of Japanese-islands. During the New Guinea campaign, Darwin-based Liberators struck at the Balikpapan oil refineries in Borneo during August, but the 17hr round-trip imposed severe restrictions on the bomb load. With the capture of Noemfoor airfield in New Guinea, 14hr round-trips with a 2,500lb bomb load were possible, using refined long-range techniques including moving crewmen about the fuselage and firing off ammunition after leaving the target. Liberators played an important role in the recapture of the Philippines and once Okinawa was taken, strikes were made against the Japanese home islands and occupied China up to VJ Day. Over 6,000 operational B-24s were on strength with the USAFF at the end of 1944, equipping forty-five groups. A year later the type was declared surplus and vast numbers scrapped literally overnight. A few B-24Ms remained until 1948 when they were redesignated ZB-24M to denote obsolete status. One of these (an EZB-24M used for ice research) continued in service until 1956 and is now displayed at Lackland AFB, Texas.

Early war-time experience had revealed the limitations of water-based patrol aircraft, in particular their vulnerability to air attack and slow speed caused by the drag of a large hull. Thus US Navy requested B-24s for land-based patrol work, a role in which the RAF had already achieved much success. In July 1942, an agreement was

made for the Navy to share production and the first B-24Ds, designated PB4Y-1s (the name Liberator was not used), arrived the following month. Erco power turrets were used on most of the 977 PB4Y-1s, and the last of these, to B-24M standard, was delivered in January 1945. In June 1943, the Navy took over from the USAAF for all anti-submarine operations and eventually twenty Navy squadrons used the PB4Y-1P from bases in Britain, Iceland, the Azores, and Ascension Island. Four squadrons were equipped with sixty-five PB4Y-1P reconnaissance aircraft with cameras in the bomb bays. Redesignated P4Y-1P in 1951, the survivors were withdrawn shortly afterwards. Several were converted to radio-controlled bombs with 21,248lb of explosives for attacks on V1 targets from England but only one successful sortie was made. One proposal, dated 1942, for a twin-engined PB4Y-1 for patrol work was referred to as the P5Y.

The RAF recieved 366 B-24Ds as Liberator IIIs and GR.Vs. The latter, for Coastal Command, had extra outer wing fuel tanks and ASV radar in chin and ventral radomes. One was tested with rockets mounted on stub wings on the forward fuselage. Eight B-24Gs and twenty-two B-24Hs became Liberator IVs. Most numerous were 1,157 Liberator IVs (B-24Js) used by fourteen squadrons in Air Command South-East Asia (ACSEA), including No.321, a Netherlands Navy unit. Some of these were transferred to the RCAF, Indian Air Force, and Czechoslovak Air Force. In addition, the RAF operated twenty four Liberator VIIs (C-87s) on Far East routes and 355 Liberator VIIIs (B-24L). All but a handful were withdrawn in 1945 and scrapped at Chakeri (Cawnpore). Two squadrons (Nos 159 and 355) continued to operate Liberators until May 1946, as unarmed photographic survey aircraft.

Seven RAAF squadrons were equipped with twelve B-24Ds, one hundred and forty-five B-24Js, eighty-three B-24Ls, forty-seven B-24Ms, and two C-87s. Over two hundred were in storage by 1948, replaced by Avro Lincolns. The RCAF received nineteen B-24Ds, forty-nine B-24Js, sixteen B-24Ls, and four B-24Ms, and the SAAF's two squadrons of Liberator VIs operated against East European targets from Foggia, Italy, from February 1944.

A sole B-24D, forced down in Siberia, was taken over by the Russians in November 1942 and France operated two in 1944. Four USAAF B-24Ds and a PB4Y-1 that landed in Portugal in 1943 were impressed and one was used for civil proving flights in April 1945. At least four B-24Js were transferred to Yugoslavia in February 1944 and operated with the USAAF's 376th BG and Turkey used at least one of several Liberators that landed in the country during the war. Another two captured B-24s were flown by the Luftwaffe on clandestine missions. In 1945, China received thirty-seven B-24Ms but the record for longevity is held by India. Hindustan Aircraft Ltd converted sixteen for maritime duties in 1948 (ex-RAF B-24Js) for No 6 Squadron and these remained in service until 1967 without a serious accident.

Quasi-civil Liberator flights began on 24 September, 1941, when BOAC started North Atlantic Return Ferry Service. A United Kingdom – Cairo service opened on 25 January, 1942, and this was followed by regular Moscow service via North Africa, Iran, and Astrakhan. Five Liberator C.IIIs were also used for Lisbon and West Africa routes. The RFS was demilitarised in September 1946, and seven Liberators were converted to all-cargo configuration and operated on the same route until April 1949, when the service was taken over by Scottish Aviation. One, operated by BOAC, was used for day and night inflight refuelling experiments over the North Atlantic with Avro Lancastrians. Five were sold to STA Alpes Maritimes in West Africa and one was converted at Marseilles into a VIP aircraft for Emperor Bao Dai of Vietnam.

Four Liberator C.IIIs were passed to QANTAS and these opened a Learmouth (Perth) – Ratmalana (Ceylon) 17-hour service on 17 June, 1944. Sydney became the terminal of the Indian Ocean route on 30 November, 1945. A Sydney–Singapore service started on 7 April, 1946, and the last of 259 Indian ocean crossings was made on 31 August. Two aircraft were used by QANTAS as freighters until 1950.

Scottish Aviation converted five Liberators to 30-passenger transports in 1946 for scheduled services between Reykjavik and Prestwick and Northolt (for Flugfelag Islands) and Northolt and Athens (for Hellenic Airlines). The Scottish fleet was also active on the Berlin Airlift but all were withdrawn in September, 1949.

Passenger-carrying B-24s were also used in Chile and Mexico in the 1950s, and six were registered in Bolivia, mostly for the carriage of meat. As late as 1969, one ex-PB4Y-1 was in use in Brazil as a transport. In the United States, a few were converted as executive transports, including an LB-30 used by Convair (under LTC-6-3) to link its New York office with San Diego and Fort Worth. For eleven years this aircraft flew with the Continental Can Co and after another eight years of executive use by Pemex in Mexico, it was acquired by the Confederate Air Force in 1967. Another LB-30 saw postwar service supporting the DEW line project with Morrison-Knudsen and has been reserved for salvage by the Alaskan Aviation Heritage Museum. Twelve complete Liberators remain preserved today, all but two in North America, and two of these are airworthy.

B-24D

Four 1,200hp Pratt & Whitney Twin Wasp R-1830-43 fourteen-cylinder air-cooled radial engines.

Crew: 9-10

Armament: Ten 0.50in machine-guns in nose, ventral, and waist positions and dorsal and tail turrets plus 8,800lb of bombs.

Span 110ft 0in; length 66ft 4in; height 17ft 11in; wing area 1,048sq ft.

Weight empty 32,605lb; maximum gross weight 60,000lb.

Maximum speed 303mph at 25,000ft; cruising speed 200mph; Climb 20,000ft/22min; service ceiling 32,000ft; range 2,300miles/5,000lb bomb load; maximum range 3,500 miles (3,664US gal fuel capacity).

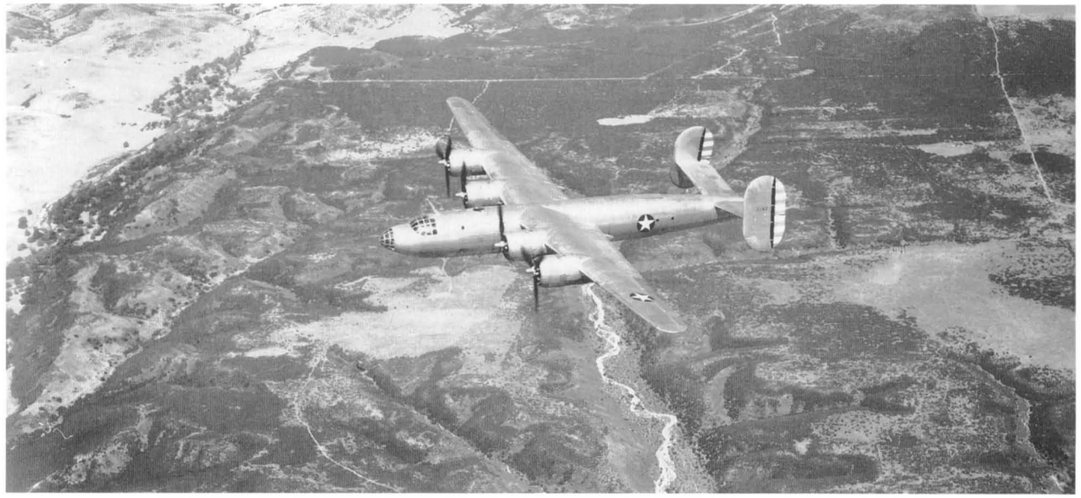
B-24H/J

Four 1,200hp Pratt & Whitney Twin Wasp R-1830-65 fourteen-cylinder air-cooled radial engines.

Span and wing area as B-24D; length 67ft 2in; height 18ft 0in.

Weight empty 36,500lb; maximum gross weight 65,000lb.

Maximum speed 300mph at 30,000ft; cruising speed 215mph; climb 20,000ft/25min; service ceiling 30,000ft; maximum range 3,300 miles (3,614US gal fuel capacity).



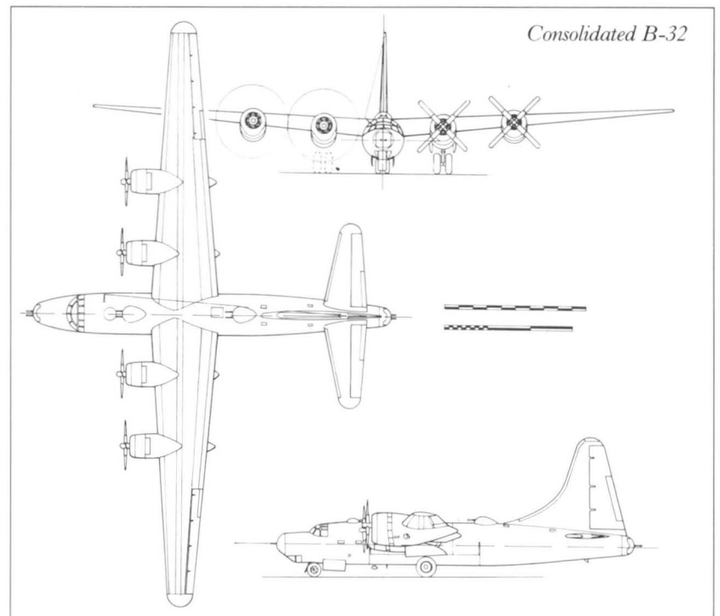
The second XB-32 on a test flight in 1943. (Convair)

Model 33 and 34 B-32 Dominator (Terminator)

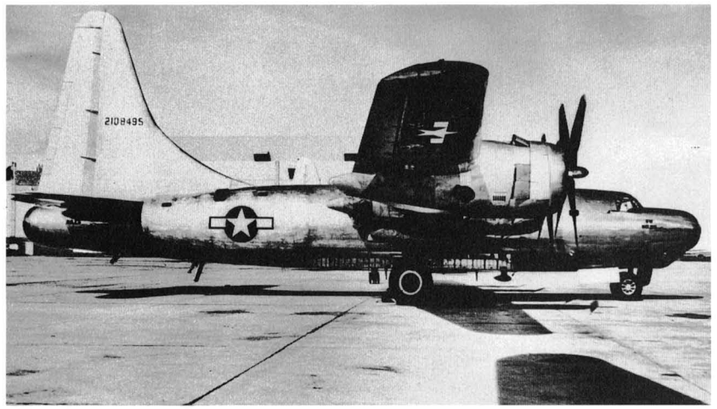
The B-32 was the result of the USAAC's specification XC-218-A, initiated in November 1939 by Gen 'Hap' Arnold, for a very-long-range bomber superior to the existing B-17 and B-24 models. On 8 April, 1940, preliminary design studies were submitted by Boeing, Lockheed, Douglas, and Consolidated and on 27 June, the USAAC Evaluation Board designated the proposals as the XB-29, XB-30, XB-31 and XB-32 respectively. Subsequently, both Lockheed and Douglas withdrew from the competition.

Consolidated's Model 33 was similar in layout to the twin-finned B-24 but with a larger Davis-type wing, longer cylindrical fuselage and rounded nose. Powered by four 2,200hp turbosupercharged Wright Duplex Cyclone R-3350s, the design had pressurised crew compartments, remotely-operated retractable gun turrets, and an estimated 101,000lb gross weight. A contract for two, later three, XB-32s was placed on 9 September, 1940, followed by thirteen YB-32s in June 1941. Instead of the original nose configuration, a stepped windscreen was incorporated.

Problems with the pressurisation system and gun turret installations caused these items (and the undercarriage doors) to be left off the first XB-32 (41-141) which was rolled out at San



The second XB-22 at San Diego. (San Diego Aerospace Museum)



One of forty TB-32-5-CFs, 42-108495 was the 25th B-32 built at Fort Worth. (John Wegg collection)

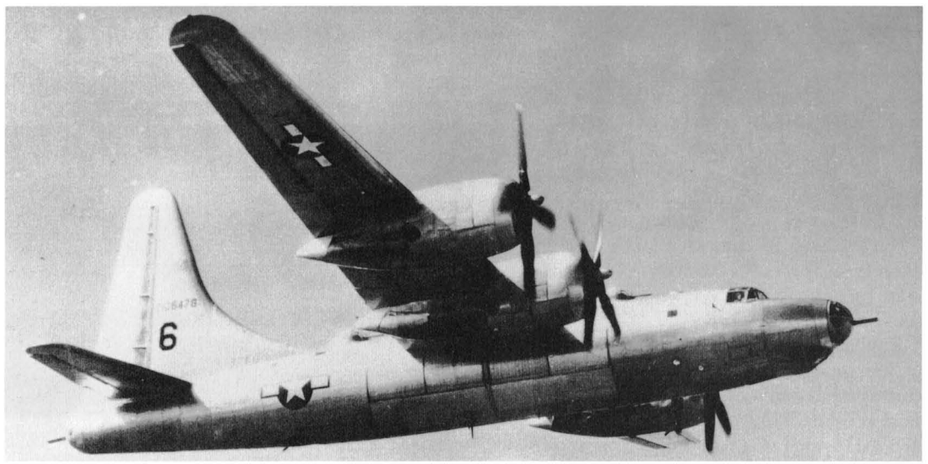
Diego almost six months behind schedule. The R-3350-13 engines inboard and R-3350-21s outboard drove three-blade Hamilton Standard Hydromatic propellers, and further postponement of the the first flight was necessary because of engine oil leaks and poor cooling. Finally, the prototype became airborne on 7 September, 1942, in the hands of Russell Rodgers, with Richard McMakin as co-pilot. However, one of the rudder trim tab actuating rods suffered a fatigue failure and after 20 minutes an emergency landing was made at nearby NAS North Island. Development problems continued and in February 1943 the YB-32 contract was cancelled, but the following month a contract for three hundred B-32 Terminators was placed, to be built at Fort Worth. On 10 May, after 30 flights, the first XB-32 crashed following a zero flap take-off attempt and McMakin was killed. The second XB-32 (41-142) was first flown on 2 July, 1943, but the USAAF soon reported that the aircraft was obsolete and recommended a large number of changes.

The XB-32 had an armament of eight 0.50in guns in top and lower turrets, two 0.50in and one 20mm gun in each outboard engine nacelle firing rearwards and controlled by aiming stations in the fuselage and tail, and two 0.50in guns in the wing leading edges, outboard of the propellers. For production aircraft this was changed to ten 0.50in guns paired in power-operated turrets in the nose, dorsal, ventral and tail positions. Pressurisation was abandoned, bomb load increased by 4,000lb to 20,000lb, and four-blade propellers specified. Stability problems caused the second XB-32 to be fitted with a B-29 style tail after its 25th flight but this still proved inadequate and a Consolidated-designed 19ft 6in vertical tail unit was substituted, and first flown on the third XB-32 (41-18336) on 3 November, 1943. However, the first production aircraft (42-108471) was also fitted with a complete B-29 vertical tail initially.

With these revisions, the design became the Model 34, and production orders were increased to over 1,500 aircraft, including a third contract for five hundred aircraft for the San Diego plant. The production plan called for San Diego to produce fuselage parts for the Fort Worth assembly line, and the latter to ship complete wing assemblies to San Diego. Powerplant auxiliary packages were built at Downey, the Stinson Division constructed the rudder, and the engines came from the Chicago plant of General Motors. In August 1944, the name of the B-32 was changed to Dominator. But in August 1945, over objections made by the State Department at a United Nations conference, that name was also dropped and the aircraft was then officially referred to by just its bomber designation and number.

The first delivery was made on 19 September, 1944, with the second Fort Worth-built aircraft (42-108472) but it was written off the same day when the nosewheel collapsed on landing. By December, only five aircraft had been delivered. In comparison the B-29 had started combat missions in June. Service tests were made at Eglin and Pinecastle, Florida, and at Wright Field and Vandalia, Ohio. Starting on 27 January, 1945, forty aircraft (42-108485/108524) were delivered as TB-32s without turrets for crew training.

Sixth production B-32-1-CF (42-108476). (A R Kreiger collection)



First production B-32-1-CF (42-108471). (Convair)

Although the B-32 exhibited good control characteristics and its unique reversible-pitch inboard 16ft 8in Curtiss propellers resulted in excellent landing performance, the type suffered from a long list of deficiencies. The cockpit had an extremely high noise level and poor instrument layout, bombardier vision was poor, it was considered overweight, the nacelle design resulted in frequent engine fires, and during May 1945, all aircraft were grounded because of undercarriage failures.

Despite these failings, there was a lack of B-29s and three B-32s were dispatched to Clark Field in the Philippines, for combat tests. Two made a ground support mission on 29 May, 1945, and six more aircraft arrived and with the other three joined the 386th Bomb Squadron at Floridablanca. In August, the unit moved to Okinawa and mostly flew photographic reconnaissance missions. The last mission was flown on 28 August, with the loss of two aircraft. One crashed on take-off and another was abandoned following technical problems. After VJ-Day, the surviving aircraft returned to the United States.

All further production was cancelled in September 1945. Besides the forty TB-32s, Fort Worth had produced seventy-four B-32s (42-108471/108484,-108525/108584) and San Diego just one (44-90486). Some were incomplete and flown directly into storage at Davis-Monthan and Kingman, Arizona, but by 1947 most had been scrapped. In June 1947, Milton J Reynolds, a pen manufacturer, announced a plan to acquire a B-32 for a flight around the world over both Poles but this did not take place. One (42-108474) was intended for display at the Air Force Museum but was scrapped at Davis-Monthan in August 1949.

The only known remnant of the B-32 in existence is a static test wing panel erected as a monument to aviation pioneer John J Montgomery on a hill near San Diego.

Four 2,200hp Wright Cyclone R-3350-23A eighteen-cylinder air-cooled radial engines each with two turbo-superchargers.

Crew: 8-12

Armament: Ten 0.50in guns paired in five turrets in nose, tail, ventral and dorsal (two) positions and 20,000lb bomb load carried internally.

Span 135ft 0in; length 82ft 1in; height 32ft 2in; wing area 1,422sq ft.

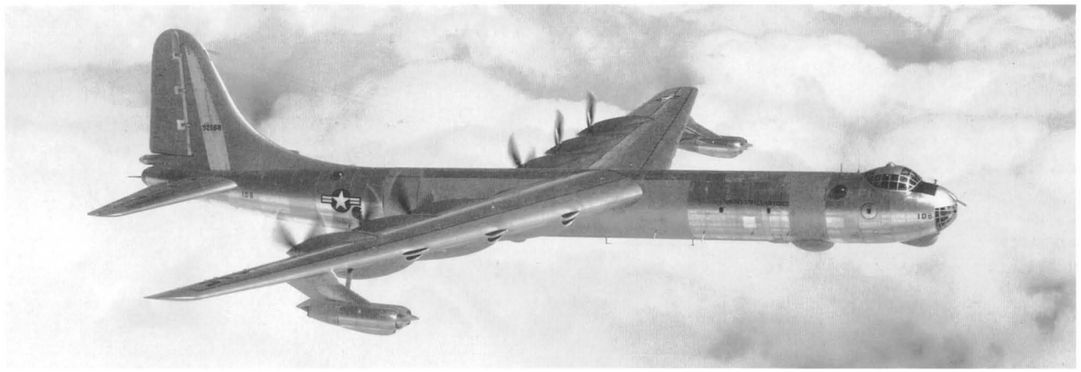
Weight empty 60,278lb; maximum gross weight 123,250lb. (recommended 100,800lb).

Maximum speed 357mph at 30,000ft; 281mph at 5,000ft; climb 1,050ft/min; 25,000ft/38min; range 2,400 miles at 20,000ft; maximum range 3,800 miles (5,460-6,960US gal fuel capacity).

Model 36 B-36 'Peacekeeper'

By spring 1941, it had become obvious that the United States would very likely be drawn into war and that there was a good possibility that all of Europe would be in Axis hands. Therefore, on 11 April, the USAAC invited Boeing and Consolidated to submit design studies for a bomber capable of achieving 450mph at 25,000ft, a range of 12,000 miles at 275mph, and a bomb load of 4,000lb at maximum range. The enormity of the requirement may be judged from the performance of the most advanced bomber then in service, the Boeing B-17C, which had a useful load of 4,000lb and a 2,000-mile range (the B-29 and B-32 were still in the mock-up stage).

Consolidated had already studied the possibility of a very-long-range bomber with six pusher engines, to improve air flow over the wing, and twin fins and rudders and this preliminary proposal (Model 35) was submitted on 3 May, 1941. Throughout the summer, Consolidated continued to refine its concept and studies continued at Boeing, and also Douglas and Northrop (on the pusher flying-wing concept, the XB-35). Following a review by Brig-Gen George S Kenney in October, a contract was approved on 15 November for Consolidated to build two prototypes, designated XB-36, for delivery in May and November 1944. Construction of a mock-up was begun at San Diego but in August 1942, because of B-24 and flying-boat work, the project was transferred to Fort Worth.



Factory-fresh RB-36D-10-CF 49-2688 (the 106th B-36). (Convair)

XB-36 42-13570 after conversion with a four-wheeled bogie undercarriage. (A R Kreiger)

In charge of the programme were Raymond C 'Sparky' Sebold, chief of engineering, and Herbert W Hinckley, project engineer.

Consolidated's original design had grown considerably, with an increase in wing span to 230ft, into the Model 36. To power this monstrous craft, Pratt & Whitney created the 3,000hp Wasp Major R-4360 by combining two fourteen-cylinder Twin Wasp R-1830s to drive 19ft three-blade Curtiss propellers. These were designed to be accessible during flight, through the 7.5ft thick wing root. To attain the revised requirement of a 10,000 mile range, six fuel tanks with a capacity of 21,116US gal were incorporated into the 4,772sq ft wing. The 163ft long circular cross-section fuselage housed four bomb bays with a maximum capacity of 42,000lb. Above these ran an 85ft long pressurised 25in diameter tube that connected the forward crew compartment with the rear gunners' compartment, complete with a trolley system for the crew to slide back and forth on. In late 1943, a single tail was decide upon as a stronger structure, almost 47ft off the ground.

In view of the engineering challenge, it is not surprising that design problems and delays occurred. However, the most persistent problem was the low priority status accorded the project throughout most of the war years. Although a letter of intent for one hundred B-36s had been issued in July 1943, mainly to help Convair recruit subcontractors for prototype construction, construction of the building in which the prototypes were to be built was not started until September. Approval from the USAAF for construction of the 8,200ft runway the B-36 would need was received as late as October 1944.

However, the enormous losses suffered in capturing island bases in the Pacific for the Boeing B-29 to operate from convinced the USAAF that there was a requirement for the B-36. With the cancellation of wartime production

The unarmed B-36A-10-CF City of Fort Worth *(44-92015) used by the 7th BG (H) at Carswell AFB for training.* (Warren Shipp)

contracts, particularly for the B-32, the B-36 programme received the impetus of personnel and material it required. On 8 September, 1945, the XB-36 (42-13570) had advanced to the point where it could be rolled out on its massive single 110in diameter main-wheel undercarriage (that restricted it to three runways in the United States that were 22in thick) but the first engine run was not made until 12 June, 1946.

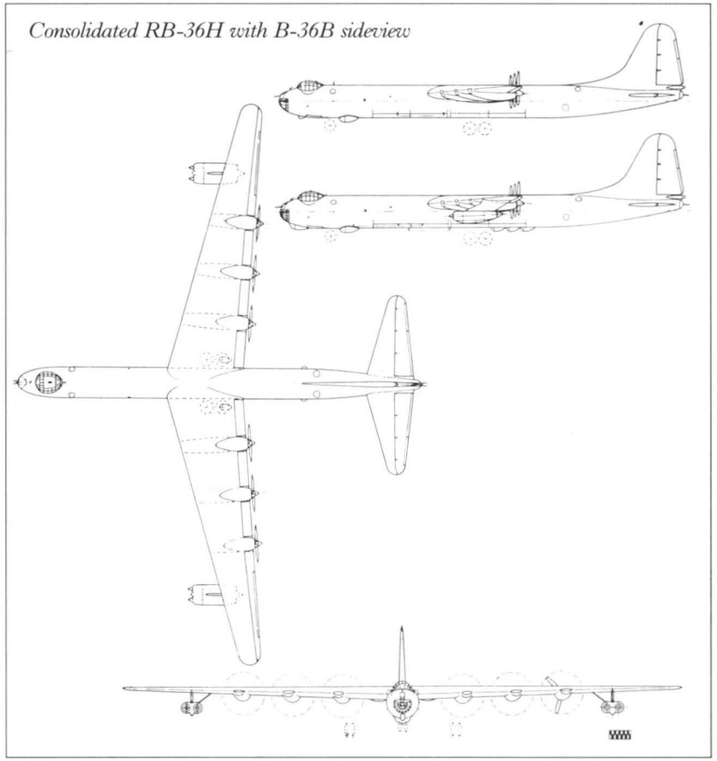
Almost five years after the prototype order, the unarmed XB-36 made its first, 38-minute, flight from Fort Worth on 8 August, 1946, in the hands of Beryl A Erickson and co-pilot G S 'Gus' Green, assisted by seven crew. Flight tests revealed several deficiencies, including poor engine cooling, rectified by improved fans, and that propeller vibration, caused by turbulent airflow off the wings, affected the wing structure. Eventually, this metal fatigue problem was partially offset by new construction techniques to spread the stress over a larger area.

Defensive armament had been revised several times, but finally settled on eight remotely-controlled turrets, all but those in the nose and tail retractable, each with two 20mm guns. The nose turret necessitated a revised cockpit layout, and a bubble canopy was adopted for production aircraft to improve visibility. After 89 hours of flight testing, the XB-36 was fitted with a four-wheel bogie main undercarriage, which reduced the runway thickness requirement to 13.5 in, and 3,500hp R-4360-41 engines. Re-flown in June 1948, it subsequently tested a track-type undercarriage at Wright Field in 1950, but was never brought up to full production standards and in 1957 was handed over to the Fort Worth firemen.

The second prototype, designated YB-36 (42-13571), flew on 4 December, 1947, with the new canopy but retained the original undercarriage. The first production B-36A (44-92004), retaining the R-4360-25s of the two prototypes, had already flown on 28 August, but this was only fitted with enough equipment for a flight to Wright Field where it was structurally tested to destruction.

A further twenty-one B-36As were completed (44-92005/92025) without armament and nineteen were delivered to the 7th Bomb Group (Heavy) across the field from the factory at Carswell AFB for training, the first on 26 June, 1948.

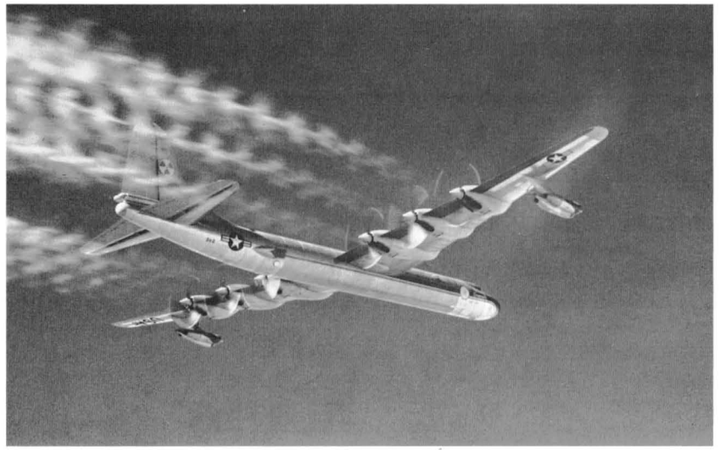
Consolidated RB-36H with B-36B sideview



Eighth Air Force B-36H-5-CF 50-1092 of the 8th BG(H). (A R Kreiger)

These were followed by sixty-two armed B-36Bs (44-92026/92087) with 3,500hp R-4360-41 engines and gross weight increased by 18,000lb to 328,000lb. First flown on 8 July, 1948, deliveries enabled a second unit, the 11th BG (H), to become operational at Carswell. On 29 January, 1949, a B-36B established a record bomb lift by taking a pair of dummy 42,000lb Grand Slam bombs aloft at Muroc, California (now Edwards AFB). Several long-distance flights were also made. On 7-8 December, 1948, the anniversary of the attack on Pearl Harbor, a 7th BG B-36B flew a 35½hour round-trip mission to Hawaii, undetected by local defence forces. The following March, a distance record of 9,600 miles was established in 43hr 37min.

Despite these impressive demon-



The NB-36H Crusader (51-5712). (Convair)

strations, all was not well with the B-36 programme. From the outset, the airframe had gradually increased in weight which, in turn, had a detrimental effect on performance to the extent that even the four-engined Boeing B-50 was faster and could serve until the jet-powered B-47 became available. Convair's answer was the B-36C, powered by a 4,300hp variable discharge turbine version (VDT, or turbo-compound) of the R-4360, the -51, but which would require a reversal to a tractor layout. In September 1947, Convair proposed that thirty-four aircraft of the original hundred be completed as B-36Cs, the extra cost of conversion met by reducing the overall order to ninety-five. However, the VDT design ran into much difficulty and the whole B-36 programme was in jeopardy when a conference to examine new B-36B performance data was held with Air Secretary Stuart Symington in June 1948. In the midst of these sessions the Soviet Union blockaded Berlin and with the so-called Cold War in full heat, a unanimous decision was made to continue with the B-36B.

But during an economy drive later in the year, the B-36 was one of the few survivors of mass cancellations and again came under scrutiny because of charges of misconduct with regard to the award of defence contracts. Further fuel was added to the controversy by Admiral Arthur W Radford, CIC Pacific Fleet, who described the B-36 as 'a billion dollar blunder'. Finally, the B-36 programme received a clean bill of health and further development continued, largely thanks to the B-36's superior range.

The speed problem was solved with the B-36D, which introduced a pair of jet engines under each wing. In order to reduce development time, the first aircraft (converted B-36B 44-92057) was first flown on 28 March, 1949, with 4,000lb st Allison J35-A-19 turbojets, already proven on the XB-47. But the 5,200lb st General Electric J47-GE-19 was adopted for production aircraft (first flown 11 July, 1949) and other improvements were quick-action bomb-bay doors, metal covered control surfaces, and new outer-panel fuel cells. The crew complement increased to 15, the bomb load to 84,000lb and the gross weight to 358,000lb. Initial vibration was eliminated by the addition of bracing struts and the B-36D demonstrated a speed of 406mph at 36,000ft and reached 43,000ft.

A total of twenty-six B-36Ds (44-92095/92098,49-2647/2668) were built and another fifty-nine B-36Bs converted to this standard by Convair at San Diego. In January 1951, six B-36Ds visited RAF Lakenheath in the United Kingdom and in 1953, deployments were made to North Africa and the Far East. As the B-36 flew well on four, or even three engines, it was common practice to shut down engines during cruise, along with the turbojets which were normally only used over the target area and for take-off.

To fulfil the Strategic Air Command (SAC) reconnaissance role, thirty-nine B-36Bs were temporarily converted with camera installations as RB-36Bs. More permanent was the RB-36D, with twenty-two crew and the bomb-bay filled with fourteen cameras, additional ECM equipment, and optional fuel tanks that increased endurance to over 50 hours. The first of twenty-four (44-92088/92094, 49-2686/2702) made its initial flight on 5 January, 1959, without turbojets, but all were delivered to the 28th Strategic Reconnaissance Group at Rapid City, North Dakota, (later Ellsworth AFB), beginning in June 1950 with them. Seven B-36Bs were converted to this standard along with twenty-one B-36As and the YB-36, but the last two conversions received the designation RB-36Es.

More powerful 3,800hp R-4360-53s were fitted to thirty-four 36Fs (49-2669/2675, 49-2677/2683, 49-2685, 50-1064/1082) which also had improved radar and ECM. The first flew on 18 November, 1950, and all were in service twelve months later. At the same time, twenty-four RB-36Fs (49-2703/2721, 50-1098/1102) were delivered. Two B-36Fs (49-2676 and -2684) were ordered as B-36Gs, with a swept wing, but the designation was changed to YB-60 (qv). Special spare parts pouches (32ft x 8ft) were built, able to carry two spare engines underneath the fuselage.

Internal changes, including an improved cockpit, were the main differences of the B-36H first flown on 5 April, 1952. Between May 1952 and July 1953, eighty-three were delivered (50-1083/1097, 51-5699/5742, 52-1343/1366) along with seventy-three RB-36Hs (50-1103/1110, 51-5743/5756, 51-13717/13741, 52-1367/1392).

The final production version was the B-36J, with an additional 2,770US gal of fuel in the outer wing panels and a gross weight of 410,000lb. The first flight was made on 3 September, 1953, and deliveries of thirty-three aircraft (52-2210/2226, 52-2812/2827) began the following month, the last to SAC on 14 August, 1954. The final fourteen were completed as B-36J(III) with all guns removed except the tail position under the Project Featherweight (Class III) programme to reduce empty weight to gain extra performance. Similar modifications were made to other models which resulted in an official ceiling of 47,000ft, although some missions were flown as high as 50,000ft. Further update work was undertaken by Convair at San Diego

The FICON GRB-36F (49-2707) carrying a Republic YF-84E (49-2115) in 1952. (Convair)

(Specialised Aircraft Maintenance, SAM-SAC) until 1957 to extend the life and capability of B-36s.

During 1951, SAC units were reorganised from groups into combat wings and by 1953, the full force of ten wings equipped with 209 B-36s and 133 RB-36s was operational at Travis AFB, California (5th), Walker AFB, New Mexico (6th), Carswell AFB, Texas (7th and 11th), Ellsworth AFB, North Dakota (28th), Loring AFB, Maine (42nd), Ramey AFB, Puerto Rico (72nd), Fairchild AFB, Washington (92nd and 99th), and Biggs AFB, Texas (95th). 'Peacemaker' was the unofficial name given to the popular B-36, a role neatly summed up by the quote from Gen Nathan F Twining, Air Force Chief of Staff, 'perhaps more than any other factor, the B-36 has kept us from being attacked.'

Early in the B-36 programme, there was a FICON (Fighter-Conveyor) project to provide the bomber with its own escort fighter, carried in the bomb-bay. The McDonnell XF-85 Goblin was ordered for this role, but limited tests with a B-29 in 1948 did not prove satisfactory. Nonetheless, Convair received a contract to convert one RB-36F (49-2707) into a FICON GRB-36F prototype to carry and retrieve a Republic F-84F in 1951. On 23 April, 1952, the first retrieval was made and on 14 May, the first composite flight. Further trials were made at Eglin AFB, Florida, which included a swept wing YF-84E. Meanwhile, the mission had changed from fighter escort to extended reconnaissance and in May 1953, a contract was issued for ten GRB-36Ds to carry the RF-84K as a parasite in an H-shaped cradle installed in the bomb bay. These saw limited service with the 99th SRW at Fairchild AFB and were teamed with RF-84Ks from the 91st SRS at nearby Larson AFB but in less than a year the trials were abandoned. The Tom-Tom trials using the GRB-36F and two RF-84Fs were similar in concept. The fighters had clamps which attached to wingtip hook-up assemblies on the B-36 so that they could be towed into the combat area. Only a few attempts to hook-up were made, the

wingtip vortices and turbulence ensuring that the operation was a dangerous affair and after one RF-84 was torn loose from the B-36's wing, the experiments were terminated.

Three B-36Hs were modified as DB-36H director aircraft for the Bell GAM-63 Rascal air-to-ground missile and another (51-5712) became the NB-36H 'Crusader', a flying test-bed for an airborne nuclear reactor. First flown on 17 September, 1955, by A S Witchell, Jr, the idea was to test the effects of radiation on the aircraft itself in connection with the WS-125A nuclear-powered bomber project. A total of forty-seven flights was completed up to 28 March, 1957, and the aircraft was scrapped a year later.

The B-52 began to replace the B-36 in SAC service during 1955 and the last B-36 (52-2827) left the 95th BW on 12 February, 1959, for display at Fort Worth. Within two years, all but three, saved for museum display, were scrapped at Davis-Monthan AFB, Arizona.

B-36B

Six 3,500hp Pratt & Whitney R-4360-41 twenty-eight-cylinder air-cooled radial engines with water injection.

Crew: 15 including 4 reliefs.

Armament: Two 20mm M24Al cannon in six retractable turrets and in nose and tail positions. Maximum bomb load 86,000lb (at restricted gross), normal up to 72,000lb.

Span 230ft 0in; length 162 ft 0in; height 46ft 9in; wing area 4,772sq ft.

Weight empty 140,640lb; gross eight 328,000lb.

Maximum speed 381mph at 34,500ft; cruising speed 202mph; climb 1,510ft/min; service ceiling 42,500ft; range 8,175 miles (21,020—26,217US gal fuel capacity).

RB-36H

Six 3,800hp Pratt & Whitney R-4360-53 air-cooled radial engines and four 5,200lb st General Electric J47 turbojets.

Crew: 16.

Armament: as B-36B.

Dimensions: as B-36B

Gross weight 358,000lb.

Maximum speed 439mph at 32,000ft; service ceiling 45,000ft; maximum range 7,690 miles (28,688—33,636US gal fuel capacity).

Model 37 (XC-99)

Six months after the XB-36 had been ordered, Consolidated began studies to adapt the wing, tail, engines and undercarriage of the bomber with a new 20ft longer doubledeck fuselage to produce a transport version. On 1 August, 1942, Laddon recommended to the USAAF that the transport be built and a prototype (43-52436) was ordered on 31 December, designated XC-99.

But in keeping with the B-36 project, priority was low and work did not begin in earnest until 1945. A set of wings and a tail unit were sent from Fort Worth to San Diego, where the pressurised fuselage, with a total volume of 30,000cu ft, the largest designed for a landplane, was built. The upper and lower cabins could accommodate four hundred troops or up to 100,000lb of cargo and the two decks were connected with staircases fore and aft. Two electrically-operated loading hatches in the lower fuselage could be opened during flight for dropping supplies. Four overhead electric hoists ran the length of both 40ft long lower cargo areas. The upper cabin, designed for personnel ran an uninterrupted 158ft.

On 23 November, 1947, the world's largest landplane was first flown from

The XC-99 on display when assigned to the San Antonio Air Materiel Area (SAAMA) at Kelly AFB. (A R Krieger)

Lindbergh Field by Russell R Rogers with co-pilot Beryl A Erikson. After the seventh flight, the XC-99 was modified at Fort Worth to B-36B standards with -41 engines and bogie undercarriage. The 100,000lb payload was lifted for the first time on 15 April, 1949, setting an unofficial world record, and on 26 May the prototype was handed over to the USAF. After being grounded a year for a structural rework to permit a gross weight of 320,000lb (55,000lb over normal), the XC-99 was transferred to Kelly AFB, Texas, in September 1950. During the Korean War, it was used for a weekly West Coast cargo service and in mid-1953, the XC-99 was based at Wiesbaden, West Germany, for several weeks. The only other recorded trips outside the United States were to Keflavik, Iceland, and to Ramey AFB, Puerto Rico. On 12 July, 1955, the XC-99 established a new passenger-carrying record for landplanes when it took 212 Air Force cadets to Fort Worth.

In 1949, a redesigned version was unsuccessfully offered to the USAF to compete with the Douglas C-124 Globemaster II. With more powerful engines and an enlarged fuselage with nose and tail doors, 183 troops could be accommodated in the upper pressurised deck and 80,000lb of cargo carried below. The crew was accommodated in a production B-36 flight deck. Other plans called for T34 or T56 propeller-turbines.

Similarly stillborn was Pan American Airways' plan, announced in February 1945, to order fifteen 204-seat luxury versions for the New York—London route. Installed for the ten hour flight would have been nine staterooms, a 12-berth sleeping section and two lounges. If fully loaded the ton-mile costs would have been the lowest for any transport, but it was soon obvious that there was nowhere near enough traffic.

Withdrawn from use in March 1957 after 7,400 hours, the XC-99 was offered for sale on the civil market. Unable to locate a buyer, the USAF donated the aircraft to the Texas chapter of the Disabled American Veterans at Kelly and for a short time, conducted tours of the aircraft were available. In 1980, the XC-99 was civil registered as N5009F although there was no change in the aircraft's status. Currently, the XC-99 remains in a semi-derelict state between Kelly and Lackland AFBs.

Six 3,500hp Pratt & Whitney R-4360-41 twenty-eight-cylinder air-cooled radial engines.

Accommodation: Five operating crew and five relief crew and up to 400 troops or 100,000lb of cargo.

Span 230ft 0in; length 182ft 6in; height 57ft 6in; wing area 4,772sq ft.

Weight empty 135,232lb; gross weight 265,000lb; maximum gross weight 320,000lb.

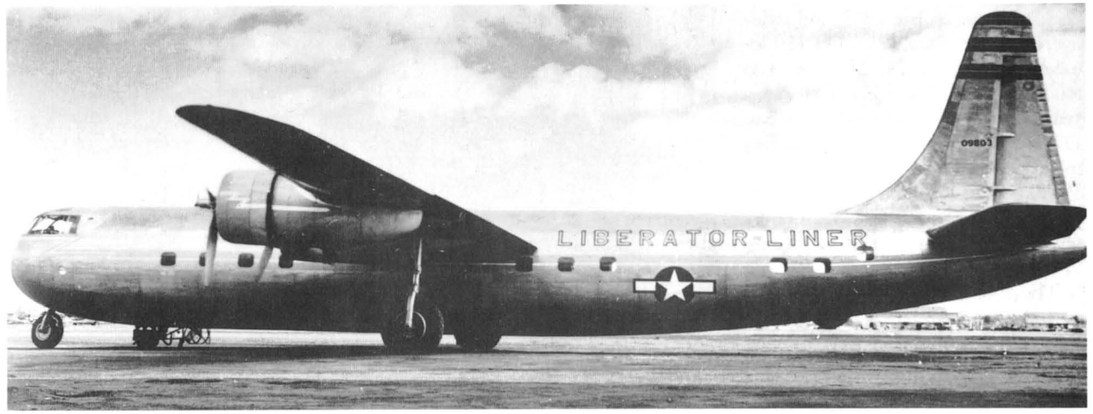
Maximum speed 307mph; service ceiling 30,000ft; maximum range 8,100 miles (19,112US gal fuel capacity) with 10,000lb payload.

The Convair XC-99 cruising along the Californian coastline; note eagle logo on nose. (Convair)

Model 39 (Convair 104) (R2Y) Liberator-Liner

An attempt to produce a pure transport version of the Liberator series, without the inherent disadvantages of converting a bomber to a cargo aircraft as in the C-87, resulted in the Model 39 which employed the wing, engines, undercarriage, and single tail of the PB4Y-2 Privateer combined with a new 10ft 6in diameter circular-section 90ft long fuselage. Provision was made for either forty-eight day passengers, twenty-four sleeping berths, or 18,500lb of cargo. A private company venture, the fuselage was built at Fort Worth and shipped to San Diego for the attachment of Privateer assemblies in early 1944. On 20 March 1944 the Navy issued a letter of intent for 253 aircraft, designated R2Y-1 (BuA 90132/90384) to be delivered between August and June 1945. However, following an inspection of a mock-up in April 1944, the Navy cancelled the contract on 6 July because of design deficiencies including a fuselage interrupted by the wing, low operational weights because of the use of components from a lighter aircraft, and an estimated lengthy take-off run.

Meanwhile, Convair requested and received permission from the Navy to fly the Model 39 prototype in military



The Liberator-Liner first appeared in US Navy colours. (Henry Clark)

The first Liberator-Liner (NX30039) as City of Salinas *on lease to American Airlines.* (American Airlines)

colours and with a Navy serial number, pending civil certification. Thus assigned the designation XR2Y-1 (BuA 09803), the Model 39 (msn 1), fitted with R-1830-94 engines, was first flown on 15 April, 1944, by Phil Prophett. The first cancelled and uncompleted R2Y-1 was purchased by Convair and finished as the second Model 39 (msn 2/NX3939) with R-1830-65 engines and was first flown on 29 September, 1944.

Together with American Airlines, Convair operated a three-month experimental cargo service from July 1945 with the first Liberator-Liner (registered NX30039 on 12 July, 1944) named *City of Salinas*. One flight was made between Chicago and Los Angeles with 55 gas ovens but more services were flown between El Centro and Salinas, California, with fresh vegetables and fruit to New York and Boston.

But there was no civil interest in the Convair Model 104 (as it was redesignated) because of availability of inexpensive surplus bombers and, soon afterwards, transports. The second aircraft made its last flight on 15 September, 1945, testing full-span flaps, five days before that of the first, and both were scrapped shortly afterwards.

Four 1,200hp Pratt & Whitney Twin Wasp R-1830-65 fourteen-cylinder air-cooled radial engines.

Accomodation: Four crew and up to forty-eight passengers or 18,500lb of cargo.

Span 110ft 0in; length 90ft 0in; height 26ft 0in; wing area 1,048sq ft.

Gross weight 64,000lb.

Cruising speed 202mph; maximum range 4,000 miles.

Model 40 (Convair 100) PB4Y-2 Privateer and Convair 101 RY-3

Experience with the PB4Y-1 led to a navalised version, specifically designed for low-altitude patrol work, designated PB4Y-2 with the name Sea Liberator, quickly changed to Privateer. Incorporating the same outer wing and nosewheel undercarriage as the Model 32, the Model 40 PB4Y-2 was considerably revised and eventually received the new model number 100 in the old Vultee series. The major structural change was the single tail, but the fuselage was lengthened by 7ft forward of the wing, the Pratt & Whitney Wasp R-1830-94 engines lacked turbosuperchargers, new nacelles were added and aft engine accessories corresponded to the R-2000, and a new electrical system installed. Eight JATO units could also be fitted. Armament was also rearranged to include twelve 0.50in guns in six turrets, an Erco nose (the first 100 had Motor Products units) and Motor Products tail, two Martin dorsal turrets, and two Erco side blisters. Up to 8,000lb of bombs could be carried and the eleven crew, including two electronics operators, had 1,171lb of protective armour plating. Cabin heating was provided by Convair exhaust heat exchangers.

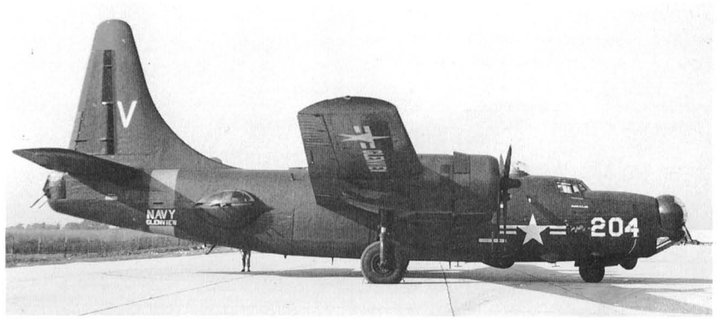
Three PB4Y-ls (BuA 32086/32095/32096) were allocated for conversion to XPB4Y-2 prototypes by Consolidated on 3 May, 1943, and all were initially flown without the single tail modification, the first on 20 September, 1943. The first two aircraft also retained the standard B-24 engine package. The three were converted to single tail configuration, initially smaller than finally

decided upon, in late 1943, and redelivered in February 1944. On 15 October, 660 PB4Y-2s were ordered followed by a second batch of 710 a year later. Deliveries began from San Diego in March 1944 and ended in October 1945 but only a total of 740 (BuA 59350/60009, 66245/66324) were completed as the remainder (BuA 66325/66394, 66795/67054, 76839/77138) were cancelled.

The first PB4Y-2s were delivered in June 1944, and two months later VPB-118 and VPB-119 were the first Fleet squadrons to receive the type. Overseas deployment began on 6 January, 1945, when VPB-118 left for operations from Tinian in the Marianas. Thirteen squadrons were fully equipped by the end of the war, and five more had a combination of PB4Y-2s and Liberators, but no score was made by PB4Y-2s against U-boats.

At least nineteen aircraft were converted to PB4Y-2B standard, capable of carrying two 1,600lb ASM-N-2 Bat radar-guided bombs, one underneath each wing outboard of the engines. On 23 April, 1945, VPB-109 launched two Bats against shipping in Balikpapan Harbour, Borneo, the first combat use of the only automatic-homing missile used in the Second World War.

Privateers continued in Fleet service until mid-1954. One regular squadron (VP-28) and two reserve units (VP-772 and VP-871) were used in support of Marine night attacks in Korea, modified to carry up to 250 high-intensity parachute flares as 'Lamp Lighter' aircraft on 'Firefly' missions. Some were used for ELINT operations with thirteen crew, and one from VP-26 was shot down over the Baltic by a Soviet fighter on 8 April, 1950. Other conversions were the PB4Y-2M, for meteorological research with turrets removed and a B-24D-type nose transparency; the PB4Y-2P photographic reconnaissance version used until 1955; the PB4Y-2S with additional anti-submarine radar; and the PB4Y-2K target drone converted by the Naval Air Development Center. In June 1951, all surviving aircraft were redesignated P4Y-2 and in 1962, a QP4Y-2 used to ferry personnel between the PMTC at Pt Mugu and St Nicholas Island became the QF-4B, although possibly it was already withdrawn from use. Nine aircraft were also transferred to the Coast Guard as PB4Y-2Gs for ASR duties.



PB4Y-2 BuA 66254 coded V/204 with NAS Glenview, Chicago. (A R Krieger)

Flotille 28F PB4Y-2s at Tan Son Nhut, Saigon, in 1954. (ECP-Armées)

Ten PB4Y-2Ss were initially supplied to the French Navy for Flottille 8F (renumbered 28F from late 1953) at Tan Son Nhut, Indochina, from 24 November, 1950, and converted to -2B standard for bombing missions. Replacement aircraft for those lost, several in action, and for 24F which was commissioned too late to see operations, brought the total supplied to 24. In March 1956, the unit began to transfer to Karouba, Tunisia, and the Privateers again saw action in the Algerian war of independence from August that year, and also flew missions during the Suez crisis. The last five remaining aircraft were scrapped early in 1961, following re-equipment with the Lockheed P2V-6 Neptune.

Privateers were also used by the Nationalist Chinese Air Force (one was shot down by Burmese fighters as late as 1961) and the Honduran Air Force used three aircraft in the transport role until the early 1970s.

A Restricted Certificate (AR-29) was issued for P4Y-2s converted for fire bombing by Transaire Spraying Co, Canyon, Texas, with a capacity of 18,000lb of slurry. Known as Super Privateers with a two-man crew and 1,700hp Wright Cyclone 14s (R-2600s), most conversions have been operated by Hawkins and Powers Aviation of Greybull, Wyoming. Some have also been fitted with nose transparencies taken from North American F-86 Sabres. Of its current fleet of six, Hawkins and Powers operated five in the fire-fighting role in 1988 and expected to keep the type in service for a few more years, well past the 50th anniversary of the first flight of its progenitor.

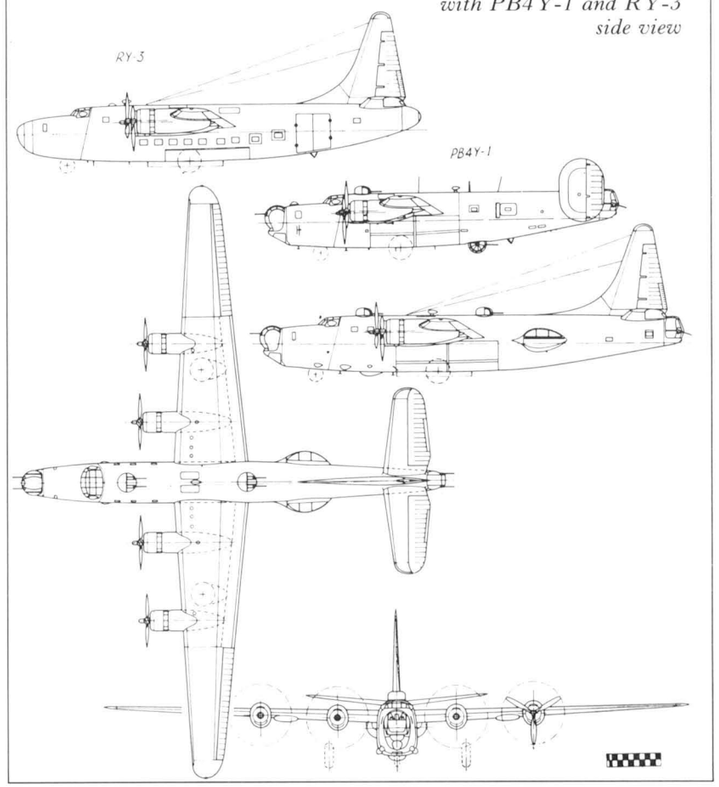
Another P4Y-2 was used for agricultural spraying by International Air

Applicators Inc. A sole Brazilian aircraft (PT-BEG) was in service in 1963, as was a Mexican example (XB-DOD), and Empresa Latino Americana de Aeronavegacion (ELDA) operated *Condor Service* freight routes within Chile and to Lima, Guayaquil, San Carlos de Bariloche, Comodoro Rivadavia, and Mendoza, Argentina, the same year. ELDA also carried passengers on a fill-up basis, one of the last users in the world of a converted Second World War bomber for passenger work.

The Model 101 was a transport version of the PB4Y-2 with a new fuselage accommodating four crew and twenty-eight passengers, or up to 25,641lb of cargo in an all-freight configuration. A hinged nose allowed up to 1,600lb of cargo in the forward section. The Navy ordered 112 in March 1944 with the designation RY-3, but only thirty-four were built (BuA 90020/90050, 90057/90059). One was retained by Convair, a few operated by the US Marine Corps, and twenty-six were supplied to the RAF as Liberator C.IXs (JT973, JT975/998, JV936). The others (BuA 90051/90056, 90060/90131) including sixty-three intended for the RAF (JV937/999) were cancelled, as was a USAAF variant designated C-87C. Before this order, LB-30 AL504 *Commando* was also converted to RY-3 configuration.

All aircraft were built at San Diego and the first RAF delivery (JT978) was on 7 February, 1945, and all were assigned to Nos.231 and 232 Squadrons, Transport Command. However, three (including *Commando*) were lost in fatal accidents and there was speculation as to the structural integrity of the aircraft. All surviving aircraft except one were struck off charge on 16 April, 1946, and were scrapped (twelve at Cartierville by Canadair). The remaining one (JT973 *Rockcliffe Ice Wagon*) was flown on ice-research flights by the RCAF until replaced by a Canadair North Star in March 1948. It too was scrapped, along with a fuselage that had been used as a snack bar near Montréal.

Consolidated PB4Y-2 Privateer with PB4Y-1 and RY-3 side view



One of a fleet of five Super Privateers still being used in the fire-fighting role by Hawkins and Powers Aviation, N2871G is ex-BuA 66302. (John Wegg)

PB4Y-2

Four 1,350hp Pratt & Whitney Twin Wasp R-1830-94 fourteen-cylinder air-cooled radial engines

Crew: 11-13

Armament: Twelve 0.50in machine-guns in six power turrets plus bomb load of 8,000lb.

Span 110ft 0in; length 74ft 7in; height 29ft 1½in; wing area 1,048sq ft.

Weight empty 39,400lb; gross weight 64,000lb.

Maximum speed 248.5mph at 12,000ft; cruising speed 158mph; climb 1,180ft/min; 10,000ft/16.3 min; service ceiling 18,300ft; range 2,630 miles/4,000lb bombs; 2,900 miles patrol (3,964US gal fuel capacity)

RY-3

As PB4Y-2 except:

Length 75ft 5¼in height 29ft in.

Weight empty 31,009lb; gross weight 60,000lb.

Consolidated Aircraft Production, Selected Types

Model 1/2/7/8/12/15 PT-Series

PT-1	USAAS	220	1 to XPT-2, 1 to XPT-3
PT-1	Siam	4	
NY-1	USN	76	conversions to NY-1A/B
NY-2	USN	181	
NY-2	USAAC	1	30-421
NY-2	NX7918	1	
NY-2A	USN	25	
NY-3	USN	20	
XN3Y-1	USN	1	
PT-3	USAAC	130	1 to XO-17, 1 to XO-17A
PT-3	Cuba	4	(possibly 4 more)
PT-3	Brazil	1	
PT-3	Peru	1	
PT-3	Argentina	1	
PT-3A	USAAC	120	
O-17	USAAC	29	
Model 7/8	RCAF	3	
Model 15		1	
		819	

Model 16 Commodore

msn

1 Model 16 built 11/9/29, NC855M NYRBA *Buenos Aires*, Pan American 15/9/30, sold in Argentina 30/1/31 as R-ACWZ, sold to Panair do Brasil 29/6/31 P-BDAJ, re-reg PP-PAJ 31/12/32, reg cancelled 24/11/38 as 'broken up'.

2 Model 16 built 5/11/29, NC658M NYRBA *Rio de Janeiro*, to P-BDAA NYRBA do Brasil 19/4/30, to Panair do Brasil PP-PAA 22/12/32, to LV-DXA SANA 3/40.

3 Model 16-1 built 26/11/29, NC659M NYRBA *Havana,* to Pan American 15/9/30, to Panair do Brasil 5/8/35 and re-reg PP-PAO 28/2/36. Reg cancelled 22/5/37 as 'returned to Pan American'.

4 Model 16-1 built 6/12/29, NC660M NYRBA *Cuba,* to Pan American 15/9/30, DBF Miami 14/4/35.

5 Model 16-1 built 31/12/29, NC661M NYRBA *New York*, to NYRBA do Brasil 19/4/30 as P-BDAE *Santos,* to Panair do Brasil 31/12/32 as PP-PAE, to LV-QAB SANA 3/40, later re-reg LV-AAL. Operations ceased 16/8/43.

6 Model 16-1 built 2/30, NC662M NYRBA *Uruguay, to NYRBA do Brasil 3/7/30 as P-BDAG São Paulo*, to Panair do Brasil 22/12/32 as PP-PAG, to Brazilian Air Force as *Manáus* 12/40, SOC 25/10/44.

7 Model 16-1 built 19/3/30, NC663M NYRBA *Trinidad,* to Pan American 15/9/30, to CNAC 1937.

8 Model 16-1 built 5/4/30, NC664M NYRBA *Puerto Rico*, to Pan American 15/9/30, to Louise A Chamberlin 1/4/37 and used by Chamberlin Air Lines, Miami; to Aircraft Exporting Co, New York, 20/4/42, reported 'dismantled' 1943.

9 Model 16-1 built 17/5/30, NC665M NYRBA *Argentina*, to NYRBA do Brasil 22/7/30 as P-BDAH, to Pan American 15/9/30, to Panair do Brasil 16/2/31 and re-reg PP-PAH 31/12/32, to Pan American 5/11/35, to CNAC 1/37.

10 Model 16-2 built 11/6/30, NC666M NYRBA *Miami,* to Pan American 15/9/30, reg in Argentina as R-ACHT 12/1/31 and in Brazil 20/3/21 as P-BDAI, to Panair do Brasil as PP-PAI 11/3/33, to Brazilian Air Force as *Belém* 9/40, crashed Belém 10/6/41.

11 Model 16-2 built 29/8/30, NC667M NYRBA, to Pan American 15/9/30, trainer up to 1940, leased to Bahamas Airways 27/10/44 and re-reg VP-BAA 1/6/45. Damaged in hurricane and broken up 1949.

12 Model 16-2 built 2/10/30, NC668M for NYRBA, to Pan American, stored 1936-43, crashed Miami 24/9/43.

13 Model 16-1 built 20/10/30, NC669M for NYRBA, to Pan American, stored from 1939, scrapped 1948.

14 Model 16-1 built 6/11/30, NC670M for NYRBA, to Pan American, based Alameda after 4/37, stored from 1940 and scrapped 1948.

Model 17,18,20 Fleetster

Fleetster msns are confusing as some original numbers were later changed, some aircraft did not have msns, and other had two sets of factory numbers. This list is in construction sequence order and only the ultimate msn and revised factory numbers are quoted.

msn/f/no.

1/17-1-1 Built 17/10/29, X657M, NC657M NYRBA 1/30 as seaplane, to Pan American 15/9/30, to Consolidated 4/31 and converted as 17GW-1 (X657M). Dismantled 1944.

2/17-1-2 Built 27/2/30, NC671M NYRBA, to Pan American, stored then scrapped 1934.

3/17-1-3 Built 22/3/30, NC700V Consolidated, to USAAC for testing until 4/31, tested with metal wing 1932, scrapped 1941.

4/17-1-4 Built 4/4/30, NC672M NYRBA, to Pan American, stored then scrapped 1934.

1/20-1-1 Built 29/4/30, NC673M NYRBA, to Pan American, stored then scrapped 1934. — Built 5/31, YIC-22 31-469 USAAC.

2/20-1-2 Built 15/5/30, NC674M NYRBA, to Pan American, stored then scrapped 1934. — Built 5/31, YIC-22 31/470 USAAC.

— Built 5/31, YIC-22 31-471 USAAC.

3/20-2-3 Built 3/6/30, CF-AIP Western Canada Airways, crashed Calgary, AB 16/11/31. 3/— Built 27/4/32, 17A NC705Y The Ludington Line, to Eastern Air Lines 2/33, to Pacific Alaska Airways 6/33, modified to 17AF 9/33.

4/20-2-4 Built 25/7/30, NC675M NYRBA (not used), Pan American (storage), to Aerovias Centrales SA as XA-BEK 2/6/34. 1/— Built 2/5/32, 17A NC703Y The Ludington Lines, to Eastern Air Lines 2/33, to Pacific Alaska Airways 5/33, modified to 17AF 9/33, to Amtorg 3/34 and marked USSR-M.S., to USSR.

-/17-1-5 Built 8/30, YIC-11 31-380 USAAC.

10/17-2-6 Built 3/9/30, NC750V Edwin Lowe, Jr, San Francisco; to Pacific International Airways, Anchorage, as *Polaris*. Rebuilt 1931 as 17-2C Special; to Consolidated then Argentine Naval Air Service as T-202. 2/— Built 27/5/32, 17A NC704Y The Ludington Line, to Eastern Air Lines 2/33, to Pacific Alaska Airways 5/33, modified to 17AF 9/33, to Amtorg 3/34 and marked USSR-S.L., w/o Kolyouchin Bay, Siberia, 29/3/34.

7/17-2-7 Built 27/2/31, 2H Special NC730N Robert R McCormick, Chicago Tribune as *Butterfly*. Caught fire on landing at Northbrook, Illinois, 28/1/32. 1/— Built 12/8/32, 20A NC13208 TWA No.50, to Charles H Babb 12/12/36, then Spanish Republican forces and shipped to Spain.

8/17-2-8 Built 6/4/31, 2H Special NC73IN George F Harding, Chicago, until 5/34, crashed Lakeview, Oregon, 6/9/43. 2/— Built 20/8/32, 20A NC13209 TWA No.51, to Condor Air Lines 11/36, eventually WFU 1948 in Alaska.

3/— Built 24/8/32, 20A NC13210 TWA No.52, to Condor Air Lines 11/36, Licence expired 6/39.

— Built 26/9/32, Model 18/XBY-1 BuA-8921 USN, WO Norfolk, Virginia, 13/4/33.

4/— Built 7/10/32, 20A NC13211 TWA No.53, to Charles H Babb 12/12/36, then Spanish Republican forces and shipped to Spain.

5/— Built 8/10/32, 20A NC13212 TWA No.54, crashed Pittsburgh, Pennsylvania 26/1/35.

6/— Built 11/10/32, 20A NC13213 TWA No.55, to Charles H Babb, then Spanish Republican forces and shipped to Spain.

7/— Built 14/10/32, 20A NC13214 TWA No.56, to Spanish Republican forces via Mexico (XA-BER).

Model 28

Consolidated-built aircraft (all but the XP3Y-1 were built at San Diego):

msn	*Type*	*Quantity*	*Serials/Regn*	*Customer/Remarks*
—	XP3Y-1	2	9459	USN, Contract 31792 28/10/33, first flown 21/3/35, rebuilt as XPBY-1 under Contract 48710 and del 6/36.
1/60	PBY-1	60	0102/0161	USN, Contract 43087 29/6/35, del 5/10/36-6/37 to VP-3/6/8/ 11/12.
1/50	PBY-2	50	0454/0503	USN, Contract 49653 25/7/36, del 5/37-2/38 to VP-2/7/10/11/17.
C-1	28-1	1	NC777	*Guba*, del 6/37, sold to Soviet Union 8/37 as SSSR-L2.
C-2	28-1	1		Soviet Union via Amtorg (Wright R-1820-G3) del 12/37.
	28-1	2		Soviet Union, shipped as major sub-assemblies 1938.

C-3	28-2	1	NC777 (2)	*Guba, del 12/37, to AM258/G-AGBJ 10/40.*
1/66	PBY-3	66	0842/0907	USN, Contract 51701 27/11/36, del 11/37-8/38 to VP-4/5/7/9/18.
1-32	PBY-4	32	1213/1244	USN, Contract 58101 18/12/37, del 5/38-6/39 to VP-1/18; 1241/1243 with waist blisters.
C-4	28-4	1	NC18997	American Export Airlines, *Transatlantic*, del 6/39, to USN 99080.
C-5	28-4	1	P9630	Air Ministry, del 7/39.
33	XPBY-5A	1	1245	USN, Contract 58101 18/12/37 for PBY-4, re-ordered 7/4/39, del 8/12/39.
—	PBY-5	167	2289/2455	USN, Contract NOs-70496 20/12/39, del 16/9/40-30/9/41. 2290 to USCG V189 10/41.
—	28-5ME	50	W8405/W8434 Z2134/Z2153	RAF, Catalina I, Contract A-37 27/1/40, del 30/11/40-21/7/41, first with 240 Sqdn. 3/41; nine to RCAF 3/417
—	28-5MA	7	AM264/AM270	RAF, Catalina II, Contract A-2587 for Australia 19/11/40, del 23/11/40-28/12/40.
—	28-5ME	40	AH530/AH569	RAF, Catalina I, Contract F-210 12/12/39, del 17/12/40-20/5/41; one to RAAF.
—	28-5MA	18	A24-1/-18	RAAF, Catalina I, Contract A-58 5/8/40, del 6/2/41-7/10/41.
232/288 range	28-5MN	36	Y-38/Y-73	NEIAF, Contract N-36 11/10/40, del 13/8/41-31/10/41.
282/317	28-5MC	36	9701/9736	RCAF Canso, Contract C-78 23/11/40, del 22/8/41-4/11/41. To RAF Catalina IIA (VA701/736).
—	28-5ME	9	AJ154/AJ162	RAF, Catalina I, Contract A-37 27/1/40, del 20/10/41-7/11/41.
—	PBY-5A	33	2456/2488	USN, Contract NOs-70496 20/12/39, del 23/10/41-19/12/41. Three to USAAF as OA-10.
—	28-5AMC	14	9737/9750	RCAF, Canso A, Contract C-78 23/11/40, del 11/11/41-31/12/41.
—	PBY-5A	134	7243/7302 4972/5045	USN, Contract NOs-77713 25/11/40, del 26/12/41-11/3/42. Two to USAAF as OA-10.
—	PBY-5A	52	02948/02977 04399/04420	USN, Contract NOs-88476LL 30/6/41. del 17/3/42-17/4/42; one to USAAF as OA-10.
—	PBY-5	90	04425/04514	USN, Contract NOs-91876 15/9/41, del 15/4/42-26/5/42.
—	PBY-5	150	FP100/FP249	RAF Catalina I, Contract NOs- 88477LL 30/6/41, del 28/5/42- 9/8/42. Sixty to USN, nine to RCAF.
837/848	28-5AMN	12	12Y-74/Y-85	NEIAF, Contract N-36 11/10/40, del 1/8/42-18/8/42 for No. 321 Sqdn.
	PBY-5A	94	08030/08123	USN, Contract NOs-88476LL 25/4/42, del 15/8/42-29/9/42. Twelve to USAAF as OA-10, twelve to RAF Catalina III (FP525/FP536).
	PBY-5B	75	FP250/FP324	RAF, Catalina IB, Contract NOs-88477 16/4/42, del 29/9/42-2/11/42,
	PBY-5	426	08124/08549	USN, Contract NOs 91876 20/4/42, del 6/11/42-20/7/43. Fourteen to New Zealand
	PBY-5B	70	JX200/269	RAF, Catalina IVA, Contract NOs-91876 30/6/42, del 23/1/43-31/7/43.

1514/1613	PBY-5A	100	33960/34059	USN, Contract NXa 13595 11/10/42, del 20/7/43-10/43. Eleven to RAF as Catalina IV (JV925/935).
1814/1943	PBY-5A	130	46450/46579	USN, Contract NOa(s)-464 12/8/43, del 10/43-12/43; thirty-six to RAAF, thirty to Free French 9/43.
1614/1813	PBY-5A	200	48252/48451	USN, Contract NOa(s)-464, del 12/43-31/3/44. Thirty-one to USAAF as OA-10.

Total Buffalo production: 1
Total San Diego production: 2,159 including 770 amphibians.

New Orleans-built aircraft (NO):

—	PBY-5	1	63992	USN, Contract NOa-259 8/7/43, del 4/44. 449 more cancelled.
1944/2002	PBY-5A	59	46580/46638	USN, Contract NOa-464 12/8/43, del 6/44-5/45.
2003/2062	PBY-6A	61	46639/46698 46724	USN Contract NOa-464 12/8/43, del 1/45-5/45.
—	PBY-6A	114	63993/64099 64101/64107	USN, Contract NOa-259 19/6/45, del 5/45-9/45. 75 to USAAF as OA-10B, 48 to Soviet Union, 64096 to PBY-6AG. 332 (64110/64441) more cancelled.

Total New Orleans production: 235 including 234 amphibians.

NAF-built aircraft:

—	PBN-1	155	02791/02945	USN Nomad, RAF Catalina V, Contract P.O.3-42 16/7/41, del 2/43-3/45. Seventeen to USN, 138 lend-lease to Soviet Union, one lost in US before del; 02802 rebuilt as 02946; 124 more cancelled.

Total NAF Philadephia production: 155

Boeing Aircraft of Canada-built aircraft:

21980/22034	PBY-5A	55	9751/9805	RCAF, Canso A, built from parts supplied by Consolidated, FF 26/7/42, del 10/42-7/43.
—	PB2B-1	200	JX270/JX437 JX586/JX617	RAF, Catalina IVB, Contract NOa-1735 31/12/42, FF 31/3/43, del 7/43-/44.; 120 assigned BuA 72992/73116; 34 to New Zealand, seven to Australia.
61094/61133	PB2B-1	40	44188/44227	USN, Contract NOa-1735 31/12/42, del 1944.
61134/61200	PB2B-2	67	44228/44294	USN, Contract NOa-782, del 9/44-5/45; 45 to RAF Catalina VI (JX618/662, JX828/JX841); 47 to RAAF (A24-300/309, 350/386, six to USAAF. Eighteen more (44295/44312 msn 61201/61218 cancelled).

Total Vancouver production: 362 including 55 amphibians.

Canadian Vickers-built and Canadair-built aircraft:

	PBY-5A	30	9806/9835	RCAF, Canso A, built at St Hubert FF 2/12/42, del from 4/43.
	PBY-5A (28.5 ACF)	109	9836/9844 11001/11100	RCAF, Canso A, built at Cartierville, del to 7/44.
CV.304/CV.608 range	PBY-5A	173	44-33868/ 44-34040	USAAF OA-10A, built at Cartierville, Contract NOa(a)-296 25/1/44,del from 12/43. BuA 67832/68004 (PBV-1A) NTU.
	PBY-5A	57	44-34041/ 44-34097	USAAF OA-10A, built by Canadair Ltd (CL-1), at Cartierville, Contract NOa(a)- 296 25/1/44, del to 2/45. 44-34054 loaned to RAAF. BuA 68005/68061 (PBV-1A) NTU.

Total Montréal production: 369 (all amphibians).

Soviet-built aircraft:

GST	An estimated 150 built at Taganrog 1940—10/41. Reports of postwar reduction are unconfirmed.

Total production (excluding USSR): 3,281 (1,428 amphibians).

Model 32

Consolidated San Diego (CO) Production:

Type	*Quantity*	*Serials*	*Remarks*
XB-24	1	39-556	Contract 12436 30/3/39, cvtd to XB-24B 39-680 and del 16/8/40 (msn 1).
YB-24	1	40-702	Contract 12464 26/4/39 for seven acft (39-681/687). Last only (msn 1) del 5/4/41 with new serial, later redesignated RB-24. Rest diverted to UK.
LB-30A	6	AM258/AM263	40-696/701 NTU Contract 12464 26/4/39 but diverted to RAF under BR-5068 16/12/40 (msn 1/6).
LB-30B (32-1)	20	AM910/AM929	Contract BR-F-677 4/6/40 to RAF Liberator I msn 1/20, del 29/3/41-26/5/41.
B-24A	9	40-2369/2377	Contract 13281 10/8/39 for 38 acft, rest built as B-24C/D. Msn 1/9 del 16/6/41-10/7/41
LB-30 (32-2)	140	AL503/AL641 FP685	Contract BR-F-677 4/6/40 to RAF Liberator II msn 1/140, del 8/8/41-31/12/41. 75 to USAAF, 23 of these to RAF later.
B-24C	9	40-2378/2386	Contract 13281 12/9/39 msn 1/9, del 20/12/41-10/2/42
B-24D	6	40-696/701	Contract 12464 26/4/39, msn 1/6 del 22/1/42-31/1/42 (replaced aircraft built as LB-30A).
B-24D	76	40-2349/2368 41-1087/1142	Contract 13281 12/9/39. msn 7/82, del 31/1/42-12/3/42.
B-24D	305	41-11587/11938 (range)	Contract 16005 18/9/40 msn 83/434, del 13/3/42-27/6/42. Eight of this batch built as B-24-CF. 41-11678 to XB-24F, 41-11822 to XB-41, 41-11653 to XF-7A.
B-24D	629	41-23640/24339 (range)	Contract DA-4 12/5/41, msn 435/1134, del 30/6/42-11/12/42, 43 to PB4Y-1.

B-24D	1,200	42-40058/41257	Contract 24620 19/2/42, msn 1135/2334, del 12/12/42-22/7/43. 42-40234 to XB-24K, 44-40344 to XB-24P. 182 to PB4Y-1.
B-24D	199	42-72765/72963	Contract 30461 29/6/42, msn 2335/2533, del 22/7/43-8/43. 26 to PB4Y-1.
B-24J	551	42-72964/73514	Contract 30461 21/11/42, msn 2534/3084, del 22/7/43-2/11/43. 54 to PB4Y-1. 42-73130 tested with B-17G nose and turret; 42-73215 testbed for GE TG-180.
B-24J	900	42-99936/100435 42-109789/110188	Contract 35312 29/6/42, msn 3085/3984, del 2/11/43-18/2/44. 78 to PB4Y-1.
B-24J	1,341	44-40049/41389	Contract 40033 21/12/43, msn 3985/5325, del 18/2/44-9/44. 258 to PB4Y-1. 44-40344 to XB-24P.
B-24L	417	44-41390/41806	Contract 40033 21/12/43, msn 5326/5742, del 7/44-31/5/45. 186 with hand held guns, rest with turrets. 186 to PB4Y-1.
B-24M	916	44-41807/42722	Contract 40033 21/12/43, msn 5743/6658, del 10/44-6/44. 250 to PB4Y-1.

Total San Diego: 6,726

Consolidated-Fort Worth (CF) Production:

B-24D	8	41-11588/11705 range	Contract 18723 20/5/41, del 4/42-7/42. Assembled from components built by San Diego on contract 16005.
B-24D	295	41-63752/64046	Contract 26992 29/5/42, msn 1/295, del 12/42-9/43. Four to PB4Y-1
B-24E	107	41-29009/29115	Contract 18723, Sup 1 26/9/41, msn 1/107, del 3/43-7/43.
B-24E	37	42-64395/64431	Contract 26992, 29/5/42, msn 108/144, del 7/43-8/43.
B-24H	70	42-64432/64501	Contract 26992 29/5/42, msn 145/153, 250/260, 308/357, del 8/43-11/43.
B-24H	493	41-29116/29608	Contract 18723 Sup 1 26/9/41, msn 154/249, 261/307, 358/707, del 8/43-2/44.
B-24H	175	42-50277/50451	Contract 18723, Sup 1 26/4/41, msn 708/882, del 2/44-5/44.
B-24J	348	42-64047/64394	Contract 26992 29/5/42, msn 296/643, del 9/43-3/44. 42-64175 to F-7A/CB-24J.
B-24J	200	42-99736/99935	Contract 26992 Sup 1 21/11/42, msn 644/843, del 1/44-3/44.
B-24J	500	44-10253/10752	Contract 40715 18/2/44, msn 844/1343, del 3/44-8/44.
B-24J	57	42-50452/50508	Contract 18723, msn 883/939, del 5/44-6/44.
B-24J	453	44-44049/44501	Contract 40033 21/12/43, msn 1344/1796, del 8/44-12/44 for RAF/RCAF.
AT-22	5	42-10726 43-30549/61/74/84	Contract 18723, del 6/43-10/43

C-87	169	various plus 42-107249/107275 43-30548/30627	Contract 18723 Sup 7 13/4/43, del 14/9/42-3/44. XC-87 41-11608 re-serialled 41-39600.
C-87	111	44-39198/39298 44-52978/52987	Contract 811, 21/3/44. msn 1/111. del 3/44-8/44. Five to Navy as RY-2 (39013/39017).
C-87A	6	various	Contract 18723, del 4/43-1/44. Three to USN as RY-1 (67797/67799).

Total Fort Worth: 3,034

939 'knockdown' airframes built by Ford were final-assembled by Fort Worth.

Douglas Tulsa Production DT:

B-24D	10	41-11754/11756 41-11864 41-23725/23727 41-23756/23758	Contract 18722 20/5/41, del 8/42-1/43, assembled from CO-built components.
B-24E	167	41-28409/28573 41-29007/29008	Contract 18722 20/5/41, msn 1/165, del 2/43-9/43.
B-24H	433	41-28574/29006	Contract 18722 20/5/41, msn 166/598, del 8/43-3/44.
B-24H	149	42-51077/51225	Contract 18722 Sup 1 11/4/42, msn 599/747, del 3/44-5/44.
B-24J	205	42-51226/51430	Contract 18722 Sup 1 11/4/42, msn 748/952, del 5/44-7/44, Another 646 were cancelled.

Total Tulsa: 964

All but first ten assembled from Ford-built components.

Ford, Ypsilanti, Willow Run Production (FO):

B-24E	490	442-6976/7464 42-7770	Contract 21216 26/9/41, -6976 and 7770 from parts, rest msn 1/488 del 9/42-8/43. 42-7221 to XC-109.
B-24H	305	42-7465/7769	Contract 21216 26/9/41, msn 489/793, del 6/43-9/43.
B-24H	700	42-52077/52776	Contract 21216 Sup 4 11/4/42, msn 794/1493, del 9/43-2/44.
B-24H	775	42-94729/95503	Contract 21216 Sup 5 10/8/42, msn 1494/2268, del 1/44-4/44.
B-24J	125	42-95504/95628	Contract 21216 Sup 5 10/8/42, msn 2269/2393, del 4/44-5/44.
B-24J	1,214	42-50509/51076 42-51431/52076	Contract 21216 Sup 32 22/6/44, msn 2394/3607, del 4/44-8/44.
B-24J	248	44-48754/49001	Contract 21216 Sup 24 19/1/44, msn 3609/3856, del 8/44-9/44.
B-24L	1,250	44-49002/50251	Contract 21216 Sup 24 19/1/44, msn 3857/5106, del 8/44-1/45. 44-49916 to XB-24Q.
XB-24N	1	44-48753	Contract 21216 Sup 24 28/1/44 for XB-24N, msn 3608, del 24/11/44.

B-24M	1,677	44-50252/51928	Contract 21216 Sup 24 19/1/44, msn 5107/6783, del 12/44-1/45. 124 cancelled.
YB-24N	7	44-52053/52059	Contract 21216 Sup 24 19/1/44, msn 6908/6914, del 5/45-29/6/45, 5,169 more cancelled.

Total Willow Run: 6,792

Ford also built 1,893 knockdown airframes (954 assembled by Douglas Tulsa, 939 by Fort Worth).

North American Dallas (Grand Prairie/Hensley Field) Production (NT):

B-24G	430	42-78045/78474	Contract 24663 1/5/42, msn 1/430, del 3/43-6/44 First 25 similar to B-24D, rest similar to B-24J.
B-24J.	536	42-78475/78794 44-28061/28276	Contract 24663 Sup 10 12/43, msn 431/966, del 5/44-11/44.

Total Dallas: 966

Total: 18,482

Selected Consolidated Projects

Model 11 (1927)

Twin-engined bomber design dropped in favour of joint project with Sikorsky based on its S-37 with two Pratt & Whitney Hornets. Known as the Consolidated Sikorsky Guardian, the prototype was built by Sikorsky. After initial tests, which revealed structural problems, Fleet decided to withdraw from the competition and the Army contract went to the Curtiss B-2 Condor.

Model 30 (XPB3Y-1) (1938)

Four-engined patrol flying-boat with R-2800-18s, span 169ft, gross weight 121,500lb; two 20mm cannon and ten 0.50in guns plus 22,000lb bomb load. Ordered 2 April, 1942, but cancelled 4 November, 1942.

Model 35 (1940)

Six-engined pusher, twin-tailed bomber design, wing span 164ft, concept developed into Model 36/B-36.

Model 38 (1942)

Land-based search attack aircraft for Navy with Model 31 wing, engines and tail with standard B-24D fuselage and armament.

OA-6 Amphibian flying-boat project, two 750hp R-1820-45s. (1936)

Trans-Atlantic Flying-Boat

In 1937, Pan American Airways, which had come under attack for its equipment acquisition policies, circulated a proposal to several manufacturers for a 100-passenger trans-oceanic flying-boat. Payload was to be 25,000lb plus sixteen crew members, with a range of 5,000 miles and preferably with turbosupercharging and pressurisation to operate at 20,000ft. Project engineer Theodore P Hall drew up a six-engined design along the lines of the Model 31 but with a thick wing seating thirty-six passengers. The remainder of the passengers were accommodated in separate cabins in three decks. Wing span was 194ft, wing area 3,450sq ft and gross weight was 168,000lb. Clearly, at a time when civil transports had engines of 1,000hp, the proposed 2,100hp liquid-cooled engines were far away and the whole scheme was impractical.

Consolidated undertook a great many design studies which were numbered in a different system to that of the Model series. The latter were only assigned if production seemed likely. The design series featured a two- or three-letter prefix followed by a number, issued consecutively. For example, the LB-12 (dated October 1938) was the 12th Land Bomber design; and the LO-1 (dated June 1939) was the first Land Observation design.

Hall-Aluminum

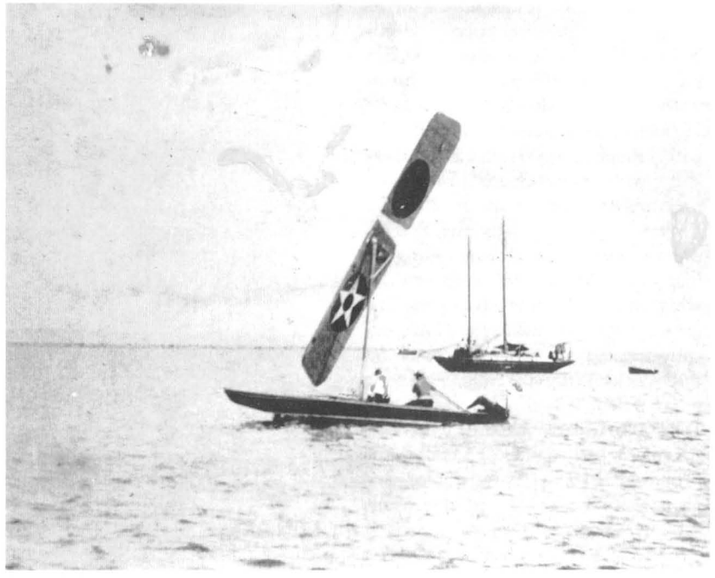
Charles Ward Hall, son of Charles Martin Hall, inventor of the process for the manufacture of aluminium, started his engineering career as a building contractor in Westchester County, New York. But his innovative and efficient practices reduced employment to the extent that he was forced out of the industry. He then turned his creativeness to the aircraft industry and in particular to metal structures.

In 1909, he was introduced to flying by Ruth Law at Daytona Beach, Florida, and when one of his sons, Charles Ward Hall Jr, joined the Lafayette Flying Corps, his interest in aviation was heightened. Hall Sr took flying lessons in 1916 under the tutelage of Dave McCollough at the Rodman Wanamaker Flying School, Port Washington, Long Island, and gained his licence on a Curtiss MF flying-boat. The same year, Charles Ward Hall Inc was established with a small factory and designing offices at Mamaroneck, New York, to concentrate on research in the use of aluminium alloys in connection with the design and construction of aircraft. Numerous patents were granted and in the immediate postwar years Hall created a 'winged boat' to sail on Long Island Sound. This was a combination of a surplus Thomas-Morse S-4 wing mated through a pivoting mast to a sailing boat hull. This experience helped him to acquire sufficient knowledge to design his first aircraft, the Hall Air Yacht in 1922.

Two years earlier, the Navy gave Hall a comparative study contract for a comparison of an aluminium wing for the normally wooden winged Curtiss HS-3. The new wing proved half as heavy as the conventional structure and as strong, but a retrofit did not prove practical. Other Navy consulting work followed, and along with custom and subcontract engineering work, this sustained the company through the lean postwar years. In 1924, Hall completed a similar comparative study for the Curtiss TS-1 fighter and in conjunction with Curtiss, built two aluminium-framed versions, designated F4C-1. Unlike the TS-1, the lower wing was raised to the bottom of the fuselage. The new structure proved to weigh 300lb less than the conventional wooden frame.

The Hall-Aluminum Aircraft Corporation was formed at Buffalo, New York, in 1927 and occupied the same premises as Consolidated in Elmwood Avenue. Charles Ward Hall was president, with his son Archibald McClay Hall as vice-president. Work continued on aluminium subassemblies for other contractors and experimental amphibian-type floats, then in 1929, two prototypes (XFH-1 and XPH-1) were produced for the Navy. The latter led to a production contract for nine PH-1s in 1930 and the design was subsequently developed and produced in small quantities as the PH-2 and PH-3 up to 1940.

A move was made to Bristol, Pennsylvania, in 1934 where the company took over the former Keystone-Fleetwings factory on Radcliffe Street, alongside the Delaware River. Charles



Charles Ward Hall's sailing boat which used a wing from a Thomas-Morse S-4. (Walter J Boyne collection)

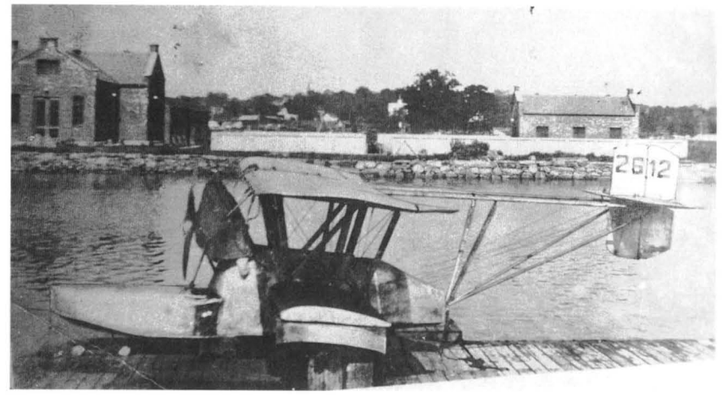
Ward Hall was killed flying the Monoped on 21 August, 1936, and was succeeded as president by his son Archibald. A sole XPTBH-2 torpedo-bomber was completed for the Navy in 1936, but no production contracts were placed.

In August 1940, Hall-Aluminum was purchased by Consolidated Aircraft. Some thirty-two key personnel were transferred to San Diego, including Archibald M Hall who became assistant to Reuben Fleet. Later, Hall served at Fort Worth, Elizabeth City, North Carolina, and at Miami. Only twenty-nine aircraft (thirty-one including the two F4C-1s) had been built by the two Hall companies in 15 years and none survive today. Hall's greatest contribution to aviation was the design and construction of aluminium sections which induced the Navy to adopt this method of fabrication for its aircraft.

Hall Aircraft Production Summary

Air Yacht	1
XFH-1	1
XPH-1	1
PH-1	9
PH-2	7
PH-3	7
XP2H-1	1
Monoped	1
XPTBH-2	1
Total	29

Hall also completed the fuselage frames for two Curtiss-Hall F4C-1s, of which one was used for static tests.



The only known photograph of the Air Yacht (2612). (Walter J Boyne collection)

Hall Aircraft

Air Yacht

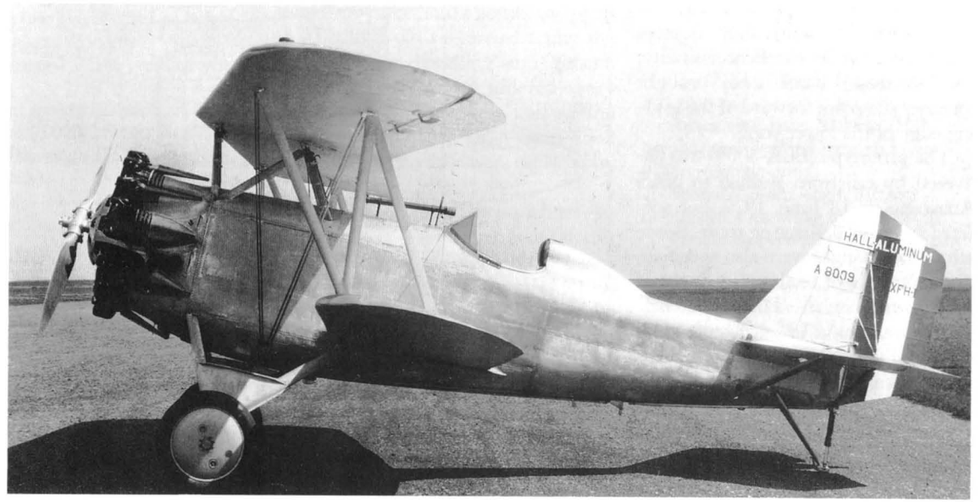
Hall's first attempt at aircraft design and construction was a two-seat sesquiplane flying-boat powered by a 60hp Wright Gale L-4 three-cylinder engine mounted on struts over the cabin. Completed in 1923, the Air Yacht had a fabric-covered upper wing of wood structure with steel lift and drag wires. But the lower stub wings, hull, and tail booms were of duralumin. The metal tail was fabric covered. As protection against salt-water corrosion, a light coating of grease was applied after a washdown following every flight.

The Air Yacht was used during the summers of 1924-26 out of Mamaroneck, or Buffalo, New York. In April 1927, it was registered (NX) 2612 with msn 333. A 75hp Cirrus II four-cylinder inline engine was to have been installed in summer 1928, but it is uncertain whether this ever took place and the aircraft does not appear to have been flown after this period. The registration was officially cancelled in May 1930.

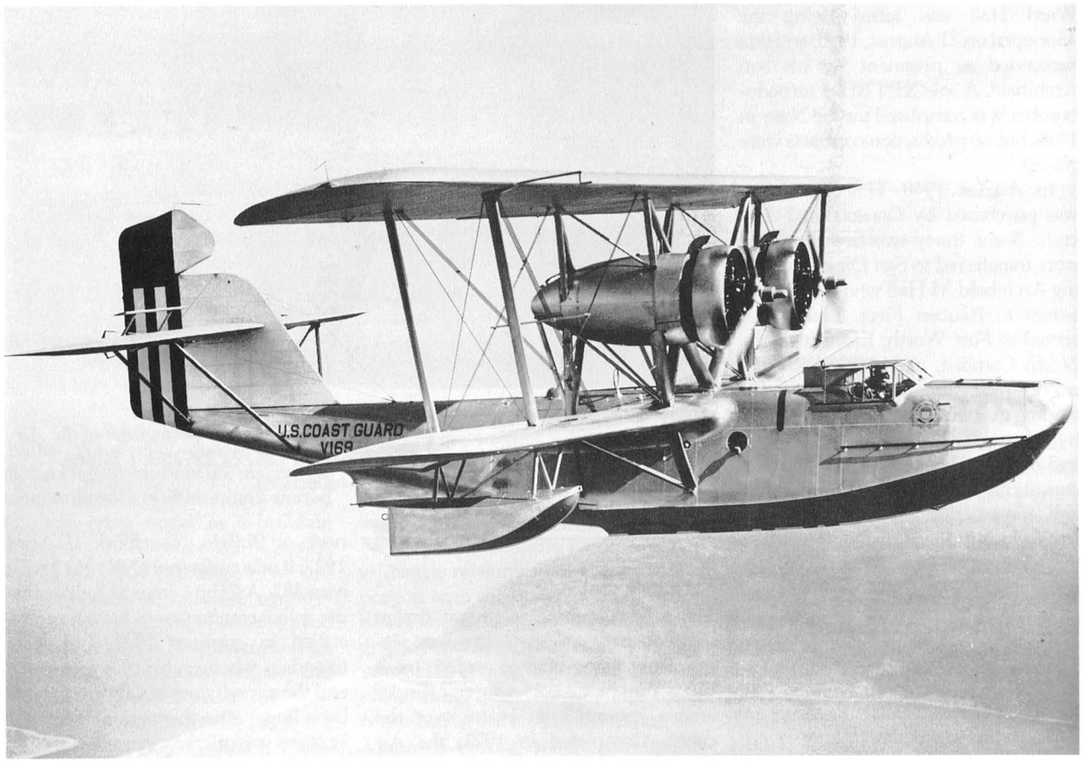
Span 25ft; length 25ft 1in; wing area 206sq ft.

Weight empty 530lb; gross weight 970lb.

Estimated maximum speed 75mph; endurance one hour.



The XFH-1 at NAS Anacostia in 1929. (US Navy)



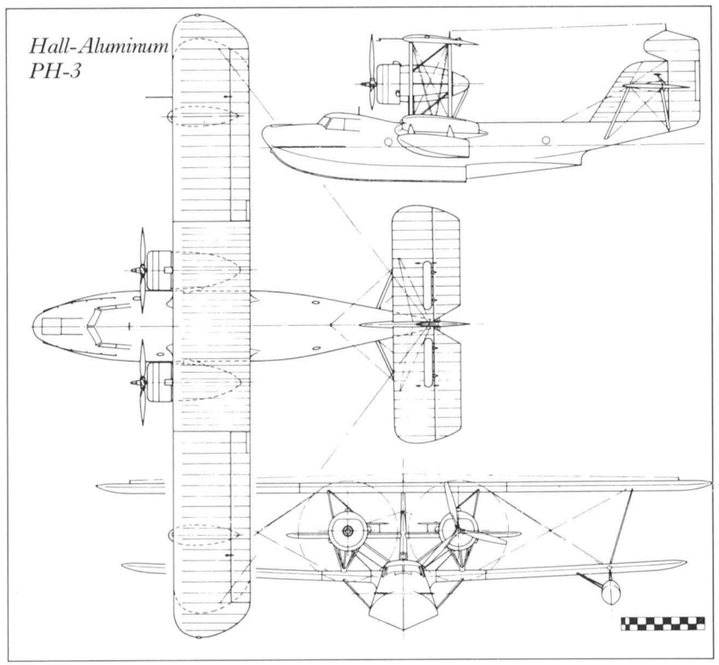
US Coast Guard PH-2 V169 (Wright R-1820-F51). (Stephen J Hudek collection)

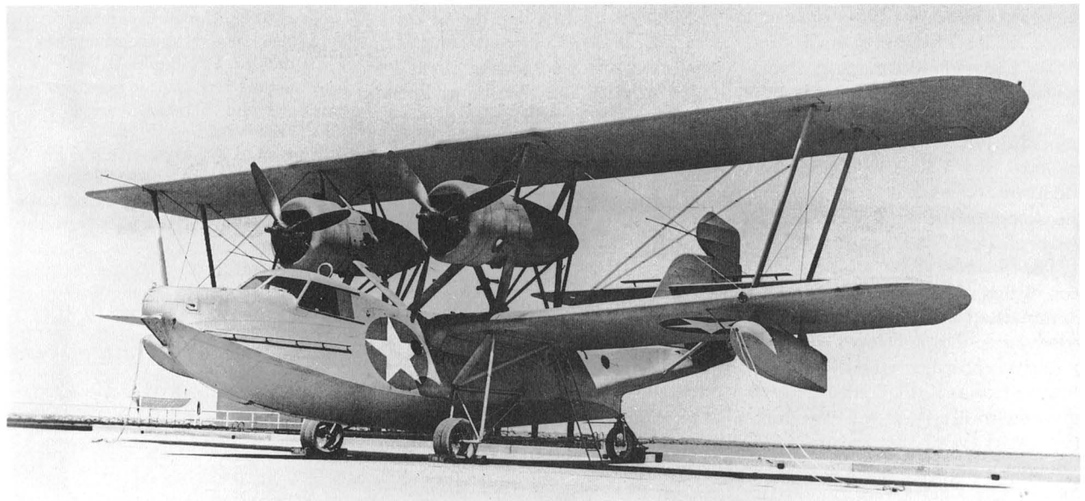
XFH-1

A prototype XFH-1 single-seat biplane fighter was ordered by the US Navy in 1929. The frame was of all-aluminium construction, with fabric-covered wings and tail surfaces and a dural-skinned watertight monocoque fuselage. In the event of a ditching, the undercarriage could be jettisoned to prevent nosing over. The upper wing was swept back six degrees, and the lower swept forward four degrees which resulted in excellent visibility, and all flying wires were brought together at a point forward of the leading edge of the lower wing.

The prototype (BuA-8009) was delivered by rail from Buffalo to NAS Anacostia on 18 June, 1929, but suffered some tail damage en route. Some structural changes were also specified, thus Navy flight testing did not start until 25 September. The rudder balancing was found unsatisfactory during initial flights and several wing ribs were bent and the stitching failed. Hall added additional ribs and more closely spaced stitching, but shortly after this work had been completed the rear upper wing spar failed during a 200mph power dive and caused a partial loss of aileron control.

Hall rebuilt and strengthened the upper wing but on 3 February, 1930,





A camouflaged Coast Guard PH-3 on its beaching gear. (A R Krieger collection)

during arrester gear trials, the Pratt & Whitney Wasp failed and the aircraft ditched with the undercarriage still attached. The fuselage design was at least vindicated, it floated for 40 minutes before being recovered. The complexity of the fuselage structure however, would have been impractical to duplicate on a production basis even if performance and manoeuvrability had been equal to contemporary designs.

One 450hp Pratt & Whitney Wasp R-1340-B nine-cylinder air-cooled radial engine.

Intended armament: two 0.30in machine-guns.

Span 32ft 0in; length 22ft 6in; height 11ft 0in; wing area 255sq ft.

Weight empty 1,773lb; gross weight 2,514lb.

Maximum speed 152.6mph at sea level; climb to 5,000ft/2.8min; service ceiling 23,500ft; range 275 miles (80US gal fuel capacity).

PH Series

On 27 December, 1927, Hall received a contract for a single XPH-1 (BuA-8004) based on the series of twin-engined patrol flying-boats produced by the Naval Aircraft Factory. The XPH-1 closely followed the lines of the twin-tailed PN-11, which had an all-metal hull and metal-framed wings, but featured an improved hull design, a larger single fin and rudder, and changes to the wing strut layout. The two pilots sat side-by-side, with one gunner forward and other behind the wings with a single 0.30in Lewis gun each, all in open cockpits. Powered by two closely cowled 537hp Wright Cyclone GR-1750Ds, it was first flown by William A 'Bill' McAvoy in December 1929.

Although there was little improvement over the PN-series with regard to performance, on 10 June, 1930, the Navy ordered nine PH-1s (BuA-8687/8695) and the first was flown on 19 October the following year. These aircraft had 620hp Wright R-1820-6 engines in short-chord cowlings which increased maximum speed by 10mph to 134mph, enclosed pilots' cockpit, twin Brownings, and a bomb load of up to 2,000lb could be carried under the wings. Water handling and general performance was considered very satisfactory by the Navy and all the PH-1s served with VP-8 from 1932 until 1937, when they were replaced by PBYs.

The good handling qualities in heavy seas and the short take-off run made the type attractive to the Coast Guard and seven PH-2s (V164/170) were ordered in June 1936. Generally similar to the earlier aircraft, they had 750hp R-1820-F51s which allowed improved cruise control techniques to increase range by 300 miles, wing area reduced by 53sq ft although the span was unchanged, no defensive armament, and special equipment for the search and rescue role. Up to four 250lb depth charges could be carried and up to twenty people in an emergency, besides the normal six crew. Delivered in 1938, the PH-2s remained in service until 1941.

In 1939, the Coast Guard went back to Hall for seven PH-3s (V-177/183), essentially the same design but with long-chord cowlings similar to those used on the XPH-1 and the cockpit covering faired into the fuselage. The first was commissioned in May 1940 and deliveries continued until January 1941. Following the attack on Pearl Harbor, the natural metal finish gave way to standard Navy green and grey camouflage and four flexibly-mounted Lewis guns were added for anti-submarine patrols. One remained in service until March 1944.

PH-3

Two 875hp Wright Cyclone R-1820-F51 nine-cylinder air-cooled radial engines.

Armament: Four 200lb or 250lb bombs on underwing racks and four 0.30in machine-guns.

Span 72ft 10in; length 51ft 0in; height 19ft 10in; wing area 1,170sq ft.

Weight empty 9,614lb; gross weight 17,679lb.

Maximum speed 159mph at 3,200ft; 153mph at sea level; cruising speed 136mph; ceiling 21,350ft; normal range 1,937 miles, maximum range 2,370 miles (750-892US gal (fuel capacity).

XP2H-1

In an attempt to investigate the possibility of extremely long-range

patrol operations, the Navy ordered a single XP2H-1 from Hall on 30 June, 1930. The largest American flying-boat since the Curtiss NC-4, it was the last Navy patrol biplane (the only solution then) and also the last with in-line engines, four Curtiss Conquerors mounted in tandem pairs between the trapezoidal-shaped metal-framed wings of Clark Y aerofoil.

The metal hull was a scaled-up version of that used on the PH-1 and accommodated six crew. Two pilots sat side-by-side in an enclosed cockpit, a gunner/bombardier was in an open bow position and a flight mechanic was aft of the main spar as were two more gunners. A crew rest station was provided amidships for extra-long-range patrols. The engines were mounted on nacelles that also enclosed radiators and two 600US gal fuel tanks. Additional fuel was carried in a series of tanks in the wings. Included in the on-board equipment was a 1½hp, air-cooled, single-cylinder petrol engine to raise the 250lb anchor.

Bill McAvoy first flew the XP2H-1 (BuA-8729) on 15 November, 1932, and extensive testing was done by Navy pilots. The maximum speed proved to be 11mph more than expected and twin-engined performance was excellent. On the two rear engines, the XP2H-1 could maintain altitude (at 1,500ft) and a slow climb could be accomplished with just the two forward engines operating. With a single engine shut down, 7,000ft could be maintained and as fuel burned off, the engines, driving fixed-pitch propellers, were stopped until the patrol finished on two engines. Excellent take-off characteristics were reported, but the flat approach resulted in a firm touchdown and in heavy seas this caused some structural problems.

Superseded by the Consolidated P2Y, the XP2H-1 did imitate the non-stop flights from NAS Norfolk, Virginia, to Coco Solo, Canal Zone, made by the Ranger in 1933, but not until 1935. The aircraft was lost when it made a forced alighting at sea and broke up.

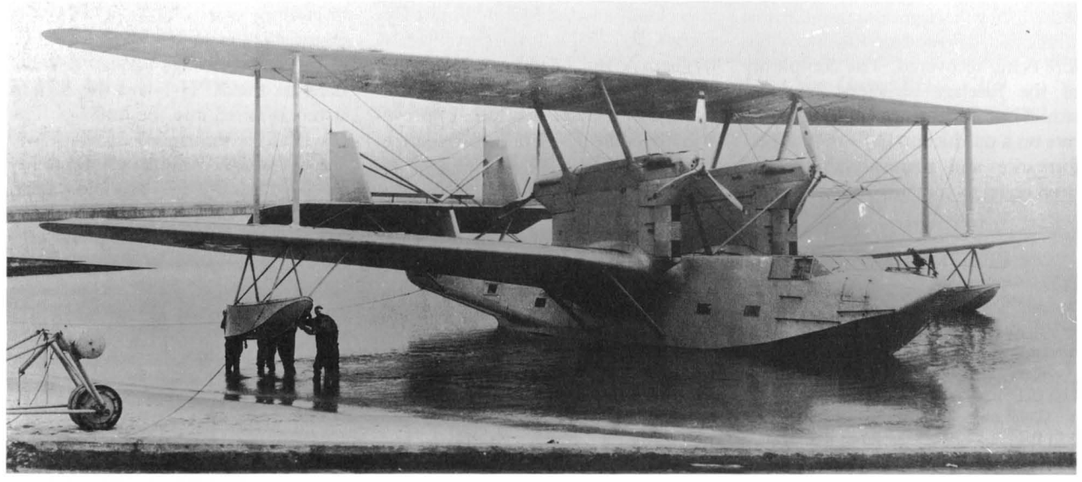
Four 600hp Curtiss Conqueror V-1570-54 inline water-cooled engines.

Armament: Five flexible 0.30in Browning machine-guns in nose, rear deck, waist and tail positions and a 2,000lb bomb load.

Span 112ft 0in; length 64ft 6½ in; height 25ft 6in; wing area 2,742sq ft.

Weight empty 20,856lb; normal gross weight 35,393lb; maximum gross weight 43,193lb.

Maximum speed 139.6mph at sea level; cruising speed 120mph climb 5,000ft/8.7min; service ceiling 10,900ft; normal range 2,150 miles, maximum range 3,350 miles (3,368US gal fuel capacity).

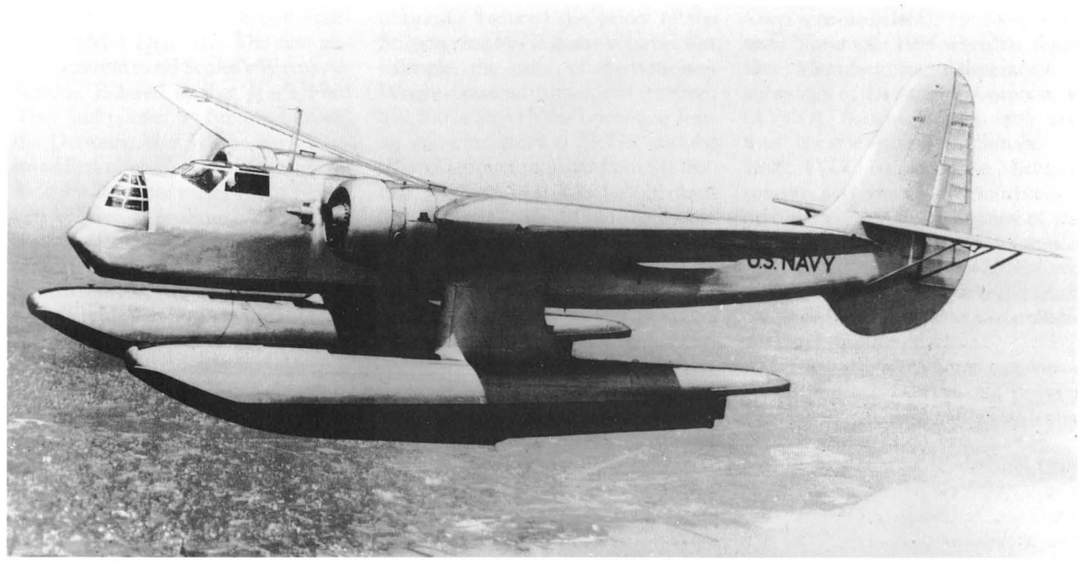


The sole XP2H-1 (Curtiss Conqueror V-1570-54). (Stephen J Hudek collection)

Monoped

Built as a personal transport and for sport flying, the Monoped was named for its unusual undercarriage which consisted of a single retractable 22in by 10.4in Goodyear air wheel mounted underneath the forward fuselage.

Monoped X777N with Hall Aluminum logo on tail. A photograph of very poor quality but great interest. (Walter J Boyne collection)



Last of the Hall line, the XPTBH-2 (Wasp XR-1830-60). (A R Krieger collection)

This view of the XPTBH-2 is given scale by the figures at the tail of the port float. (Peter M Bowers collection)

Small outrigger wheels were also mounted on the lifting struts. A 125hp Ranger 390 six-cylinder air-cooled inline engine drove a Hamilton-Standard metal propeller. Another un common feature was an overhead control column (tried on the Consolidated Model 10). Reportedly a delightful aeroplane to fly, the Monoped (X777N) struck a tree in fog at Hopewell, New Jersey, on 21 August, 1936, killing Charles Ward Hall. Up to then, over 530 hours had been logged.

Span 32ft; length 25ft

Maximum speed 130mph.

(approximate figures)

XPTBH-2

In answer to a Navy requirement for a seaplane torpedo bomber capable of carrying the standard destroyer-type weapon, almost twice the size of the normal aerial torpedoes, Hall designed a twin-float, twin-engine monoplane. One aircraft was ordered on 30 June, 1934, as the XPTBH-1 (BuA-9721) with Wright Cyclone R-1820s but completed as the XPTBH-2 with 800hp Pratt & Whitney Wasp XR-1830-60s driving three-bladed electric Curtiss propellers.

The fabric-covered wing, with similarly-covered ailerons and trailing-edge flaps, was built up of a single tubular aluminium spar, with a diameter of 36in at the root and 9in at the tip. Connected to the spar through similar tubing, the cantilever floats allowed a free drop for the torpedo or 1,000lb bomb load which were carried in an internal bay. The fuselage housed four crew who all performed secondary functions. A single 0.30in gun was mounted in a Hall-designed nose turret with another 0.30in and one 0.50in in dorsal and ventral gun positions.

First flown by Bill McAvoy, the prototype was delivered on 30 January, 1937, but although it performed well there were no Navy procurement plans for a water-based torpedo bomber. The XPTBH-1 was destroyed in a hurricane at Newport, Rhode Island, in November 1938.

Span 79ft 4in; length 55ft 11in; height 24ft 1in; wing area 828sq ft.

Weight empty 11,992lb; gross weight 17,983lb; maximum gross weight 21,414lb.

Maximum speed 182mph at 8,000ft; 169mph at sea level; climb 5,000/5.3min; service ceiling 19,200ft; range with torpedo 850 miles; maximum range 2,620 miles; (830-1,180US gal fuel capacity).

Stinson

Eddie Stinson, 'the dean of American flyers'. (Wayne Historical Society)

Known as the 'dean of American flyers', Edward A 'Eddie' Stinson was partly of Cherokee Indian heritage and owed his start in aviation to his sister, Katherine. Katherine Stinson had gained her pilot's licence, the fourth woman in the United States to do so, at the age of 21 in July 1912 and became a noted exhibition flyer during the pre-Great War days. Another sister, Marjorie, was taught to fly at the Wright School at Dayton in 1914 by Howard Rinehart, later chief pilot for Dayton Wright, and in 1915, Eddie also took some lessons at the Wright School. In October 1915, the Stinson sisters started a flying school at San Antonio, Texas, and on 29 December, Eddie gained his pilot's licence along with the Stinsons' first class of five Canadians.

Besides acting as a mechanic for his sisters' operation, Eddie also assisted Walter L Brock to build two exhibition aircraft and became an instructor at the Stinson School of Flying. In 1916, Eddie instructed at Fort Sam Houston, San Antonio, then at a Curtiss-run school at Newport News, Virginia, after the United States entered the war. Stinson also did some flight-test work for Curtiss and gained a reputation for 'stunting', seemingly looping every type of aircraft, large or small, that he flew. However, he was an exceptionally gifted pilot capable of masterly handling of the frequently unreliable and always underpowered training types.

After the war, Eddie spent most of his time operating as a professional test pilot, instructor, barnstormer, and air-taxi service for passengers and newspaper photographs, based at Packard Field, Detroit, Michigan, from 1922. Stinson set the first of several endurance records on 29/30 December, 1921, when he and Lloyd Bertaud took-off from Roosevelt Field, Long Island, in a snowstorm and circled their Larsen JL-6 (Junkers-F 13) for 26 hours 19 minutes. A year and a half later, on 26 July, 1923, in the same type of aircraft, Eddie Stinson made the first nonstop night flight between Chicago and New York.

In 1925, a few days after the Ford Reliability Air Tour had taken place, Stinson approached two aquaintances who sat on the Detroit Board of Commerce, Harvey J Campbell and William A Mara, with the preliminary plans for a new aircraft. Eliciting their support, Eddie formed the Stinson Airplane Syndicate. Other prominent Detroiters who invested in the enterprise included Frank W Blair, head of Guaranty Trust, and William E Metzger, involved in the automobile industry. A loft in Congress Street, etroit, was rented and that winter, Stinson supervised construction of a four-seat cabin biplane, the Detroiter, which was first flown from Selfridge Field in January 1926.

A sale of one aircraft to Horace Dodge, of the motor family, and the raising of more capital from Detroiters, led to the formation of the Stinson Aircraft Corporation which was formed on 2 May, 1926, to produce a refined version, the SB-1. Eddie Stinson was president of the new concern, with William Mara as secretary, Harvey Campbell as vice-president, and James M Evans, chairman. A two-storey wooden building was obtained in the Detroit suburb of Northville and production of the SB-1 began in August. Flying was conducted from a farmer's adjacent field. That year, eight aircraft were sold.

The following year, Stinson produced a monoplane version of the SB-1, the SM-1 Detroiter. The first aircraft was sold to Ed Schlee's Wayco Air Service. Entered in that year's Ford Tour and piloted by Stinson himself, the Detroiter *Miss Wayco* easily captured first place.Renamed *Pride of Detroit*, the Detroiter was flown by Schlee and William S Brock in a remarkable around-the-world flight attempt. Reaching Japan 18 days after leaving Newfoundland, in light of the US Navy's refusal to provide surface support, the two fliers decided not to risk the hazardous trans-Pacific crossing, and returned to the USA by ship. Many other Detroiters were used for other equally-well publicised record-breaking attempts which brought fame to the Stinson company. To supplement the Detroiter, a Detroiter Junior appeared in 1928 aimed at the executive market. Stinson Aircraft sales rose from thirty-four aircraft in 1927 to ninety-seven a year later.

Through the sale of 23,500 shares of stock, additional capital was raised in 1928 to purchase a 10-acre parcel of land for a new factory at Wayne, Michigan, adjoining the Detroit Municipal Airport. Construction started in January 1929 and work on the 90,000 sq ft building was complete by August. During the same month, Stinson obtained money for expansion through the sale of a controlling interest in the company to the Cord Corporation, headed by one of Stinson's oldest customers, Errett Lobban Cord. As Cord controlled the Lycoming Manufacturing Company, of Williamsport, Pennsylvania, one of the first actions was to put the Lycoming R-680 engine into the Junior, previously powered by the Wright Whirlwind.

The following year, Corman Aircraft Inc, a joint venture of Cord's and his associate Lucius B Manning, was merged into Stinson. In April 1930, at the All-American Aircraft Show at Detroit, Stinson announced its Model 6000, an enlarged and improved version of the Corman trimotor airliner. In 1931, Cord founded two airlines, Century Air Lines, and Century Pacific Lines, which used the 11-seat Stinson trimotors exclusively. The collapse of the stock market in October 1929 and the onset of the Great Depression curtailed the production of most aircraft manufacturers, but Cord drastically reduced the prices of the Stinson range to increase volume. For example, the price of the four-seat Wright-powered Junior was cut from $10,500 to $8,495; the Lycoming Junior was introduced at $5,775; and the Wasp Detroiter reduced from $18,500 to $15,995. In 1931, Cord could claim that 75 per cent of all American four-seat cabin aircraft and 70 per cent of all American airliners sold that year were Stinsons. Cord also built a new service hangar at Wayne and expanded the size of the factory to include an engineering department, motor division, and stock room.

In spring 1931, engineers Robert W Ayer, formerly with the Granville Brothers, and C R 'Jack' Irvine, joined the company and began work on a completely revised Junior, the Model R. On 25 January, 1932, the new Stinson R received its type certificate and Eddie Stinson flew to Chicago on the first leg of a nationwide sales tour. After an afternoon of demonstration flights, Eddie took-off at dusk with three prospects. But he had neglected to refuel and after a few minutes the engine failed over Lake Michigan. Returning to the shoreline for a forced landing, the Model R struck a flag pole approaching Jackson Park golf course. All the occupants were injured but Stinson was able to walk into the hospital admittance room. There he collapsed. After 15,000 hours in the air, the popular and hard-driving 38-year-old Stinson died early the next morning without regaining consciousness.

The famous bow and arrow Stinson logo was modified and reproduced in different forms over the years. After the Second World War, it was turned to face forwards, not upwards.

The tragic event was a further blow to Stinson Aircraft, suffering from the effects of the economic recession. Lucius B Manning became president of Stinson Aircraft (he was also a Cord Corp vice-president). He held office until November 1934 when the Aviation Manufacturing Corporation, a subsidiary of the Aviation Corporation (AVCO), bought Cord's stock and thus became parent to Stinson. In 1938, AVCO liquidated the Michigan concern and Stinson Aircraft became one of the operating divisions of the Aviation Manufacturing Corporation (AMC). Chairman was W H Beal and president was A I Lodwick. Bill Mara continued with Stinson as a vice-president and director of sales.

The Model U trimotor was introduced in 1932, but did not prove a popular aircraft. Also tail-heavy, a new tail was designed by project engineer Sam Benson. On a test flight in February 1933, violent tail flutter in a dive caused the crash of a Model U with the loss of Benson, chief engineer Art Saxon, and chief pilot Owen H Pinaire. Ayer took over the latter's position and in 1933, designed the 'eight- passenger plus hostess' Model A trimotor for American Airways. However, the type experienced several accidents, although not of a design nature, and airliner sales dwindled as more modern types became available from other manufacturers. There was also a brief foray into the military trainer field with the Model O designed by Robert L Hall who joined the company in 1933.

However, Stinson concentrated on the single-engined executive market (a twin-engined version of the Model A for this purpose, the Model B, was not put into production) and launched the Reliant series in 1933 as 'transport planes for private people'. For the next five years, new models of the Reliant comprised the major activity of the company and 750 civil examples were built until all civil production ceased in 1941. In 1939, Stinson entered the low-price private aircraft field for the first time with the HW-75 Voyager 105 which was hugely successful.

On 22 October, 1939, Stinson became a division of Vultee Aircraft (itself incorporated on 14 November, 1939, when it acquired the assets of AMC) through a stock transfer arrangement engineered by their common parent company, AVCO. The same month, AVCO completed negotiations for a new manufacturing site for Stinson adjoining Berry Field, Nashville,

Tennnessee. A new 180,000sq ft factory was built and Stinson was moved there in May 1940 and produced mostly HW-80 Voyagers. However, the Nashville plant was expanded to 817,000sq ft and on 8 August, 1940, officially purchased by Vultee for large-scale Vigilant and Vengeance production. Therefore, Stinson returned to the Wayne site which was increased in size to 158,000 sq ft.

At Wayne, civil work came to a halt in 1941 and production switched to the Model 76 Sentinel (L-5), and, from July 1942, a military variant of the SR-10J Reliant. On 25 November, 1941, Consolidated and Vultee were brought together under the control of Victor Emanuel, head of AVCO, which resulted in a near merger of the two companies. Stinson continued as a division of Vultee until March 1943, when it became the Stinson Division of Convair (Consolidated Vultee). Employment at Wayne peaked at 1,989 in July 1943.

After the war, production quickly resumed of the improved Model 108 Voyager to meet the anticipated light aircraft boom. Over 5,000 Voyagers were produced and in 1947, this type accounted for almost half the United States production of four-seat private aircraft. For a time, the Stinson Division was the only one in the Convair conglomerate making any money. However, over-production of light aircraft in the immediate postwar years halved the industry's total units, down from 34,874 in 1946, to 15,616 in 1947, and by 1948 unsold Voyagers were leaving the line for immediate storage. Combined with the retrenchment forced upon Convair by the overall aircraft manufacturing industry's postwar collapse and huge start-up losses on the Convair-Liner project, which resulted in the takeover of Convair by the Atlas Corporation in November 1947, the Stinson factory was closed on 30 June, 1948. On the following 1 December, the name, assets and goodwill of Stinson were sold to the Piper Aircraft Corporation.

On 27 April, 1949, Piper established a Stinson division to market some two hundred unsold Voyagers and also assembled another 125 from existing Stinson-built spares. These were marketed as Piper-Stinson 108s. In 1952, Piper produced a twin-engined light aircraft based upon a 1948-design proposal. Called the Twin-Stinson, presumably to capitalise on the respected Stinson name in the executive field, it was eventually refined into the PA-23 Apache. Subsequently, all Stinson data and rights to the L-5/Voyager series were sold to Universal Aircraft Industries, Sky Ranch Airport, Denver, Colorado.

Stinson Production Summary

Detroiter	1
SB-1 Detroiter	26
SM-1/6 Detroiter	123[1]
SM-2/7/8/S/W Junior	500[1]
SM-3	1
SM-4	1
SM-5	1
SM-9	1
SM-6000	53
Model A (amphibian)	1
Model R	39
Model M	1
Model U	24
Model O	9
SR Reliant (straight wing)	287
Model A (trimotor)	31
Model L	1
SR Reliant (gull wing)	488
V-77 Reliant	500
Voyager (prewar)	1,035[5]
Model 74 (O-49)	324
Model 75	1
Model 76	3,608[2]
Model 103	1[3]
Model 105	2[4]
Model 106	1[3]
Model 108 Voyager	5,260
Total	12,320

1 In 1929, production moved from Northville to Wayne

2 According to serials allocated, but USAAF only quotes 3,590 delivered. Aircraft serial numbers in the -4200 range have been reported.

3 Built by Stinson Division of Convair

4 Remainder by Convair

5 Some production at Nashville until factory taken over by Vultee for the Vengeance.

In addition, 30 Faucett F-19s were built in Peru (based on the SM-6 Detroiter).

Stinson Aircraft

Detroiter, SB-1

During 1925, Eddie Stinson drew up rough plans for a four-seat cabin biplane and with financial assistance from the Detroit Board of Commerce, constructed a prototype in a Congress Street loft in Detroit during that winter. He received help with the design from Professor Peter Altman of the University of Detroit Aeronautics Department and engineer William C Naylor.

The prototype Detroiter was flown for the first time from Selfridge Field on 25 January, 1926, by Stinson accompanied by Bill Mara and Dick Fitzgerald. Powered by a 200hp Wright J-4B Whirlwind driving a Curtiss-Reid propeller, the Detroiter had an electric starter, fully enclosed cockpit with an exhaust-manifold heater, and individual wheel brakes. All were new features for the day and it is thought that this was the first time that the three had appeared on one aircraft.

Early the following month, the prototype had its first public airing at Packard Field and carried eighty passengers. On one occasion Stinson had to hand swing the propeller to start and when the engine caught his passenger, who had remained in the cabin, opened instead of closing the throttle and the Detroiter collided with a hot dog stand. From then on a parking brake was installed.

In May 1926, the Stinson Aircraft Corporation was formed, with a factory in the Detroit suburb of Northville, and production began in August of an improved five-seat model, the SB-1, with deeper fuselage lines, revised wing bracing, and a new tail unit. Construction was similar to the prototype, with a fuselage and tail surfaces of steel tube and wooden wings with spruce spars, the whole framework covered with fabric. Aerofoil USA 35B was used and the 70US gal fuel capacity was contained in two upper wing tanks and the tailplane was adjustable in flight.

The prototype attracted attention when it was flown by Stinson to third place in the August 1926 Ford Reliability Air Tour. The first two production aircraft apparently went to Ed Schlee's Wayco Air Services and Florida Airways respectively. Newly-formed Northwest Airways received two in October, with another later, and these started air mail service between Minneapolis-St Paul and Chicago on 2 November. Passenger services on the same route did not start until the following 5 July.

Priced at around $11,000, the SB-1 was also used by Patricia Airways and Exploration Ltd, in Canada. Two, powered by 220hp J-5Cs, were used by Sir George Hubert Wilkins on his Arctic exploration expedition in 1927, sponsored by the *Detroit News*. One crashlanded with Wilkins and Ben Eielson on board north of Point Barrow, Alaska, on pack ice and was abandoned. The other (C5262 msn 5) was sold to Noel Wien for his Fairbanks-based airline.

Approved Type Certificate 24 was awarded in January 1928 but production of at least twenty-six SB-1s (later aircraft with the J-5) had already been completed by June the previous year. One was tested with floats and the SB-1 Special was approved as a three-seater (for msn 1, 3, 90) on 4 March, 1931 (ATC 2-330).

One 200hp Wright J-4 Whirlwind nine-cylinder air-cooled radial engine

Span 35ft 10in; length 28ft 10in; height 10ft 3in; wing area 350sq ft.

Weight empty 1,700lb; gross weight 2,900lb.

Maximum speed 118mph; cruising speed 100mph, climb 800ft/min; ceiling 13,500ft; range 600 miles.

The unregistered prototype Detroiter photographed on 10 March, 1926. The name Stinson is painted across the underside of the lower wing. (Ford Motor Co)

Another view of the prototype Detroiter photographed on 10 March 1926. (Ford Motor Co)

SB-1 NC3027 of Wayco Air Services has not been identified by manufacturer's serial number. (Ford Motor Co)

SB-1 (NC)2707 (msn 90) of Club Wise Birds Inc, Detroit, was later used by Northwest Airlines. (Frank Walters)

SM-1 Detroiter

Although the SB-1 sold relatively well, Stinson believed a more popular and efficient aircraft would be a monoplane version. Consequently, a six-seat stretched fuselage version was designed by William C Naylor to the general specifications of Stinson. Powered by a 220 hp Wright J-5C, the SM-1 Detroiter (Stinson Monoplane-1) first flew at Northville in April 1927 and retained the fabric-covered welded steel-tube fuselage and spruce and plywood wing construction of the SB-1.

Wide wing bracing struts on each side, built up of steel tubing and balsa wood and fabric-covered, added to the lifting area of the nearly 46ft span wing of NACA M-6 aerofoil. Also adopted from the SB-1 was the split-axle undercarriage although on later models this was changed to a wide-track outrigger type using oleo shock absorber struts. Wing-mounted navigation lights, engine starter, wheel brakes and metal propeller were all standard equipment. The cabin contained six wicker chairs in pairs with a six-inch aisle in between. A door was provided either side and dual controls for the forward two seats.

Despite its rather unwieldy appearance, the SM-1 handled well and very quickly established a good reputation, thanks to the demand for a long-range record-breaking type in the wake of Lindbergh's transatlantic achievement in May. With passenger seats removed, the ample fuselage of the Detroiter could be filled with extra fuel tanks.

The second aircraft (NC857 msn M201) was sold to Edward F Schlee (president of the Wayco Oil Co) and named *Miss Wayco*, was flown by Stinson to victory in the 1927 Ford Reliability Air Tour. Renamed *Pride of Detroit*, it was used for a remarkable round-the-world flight by Schlee and William S 'Billy' Brock. Leaving Harbour Grace, Newfoundland, on 27 August they landed at Croydon the next day after a 23-hour flight termed by the American Embassy in London as one with 'no international significance'! Following a short stay in England, the flyers continued through Europe and Asia to Japan, arriving in Tokyo on 14 September. They had covered over 12,000 miles in 145 hours. With the US Navy's refusal to provide surface support for the hazardous Pacific crossing, the wise decision was taken to return to the USA by ship.

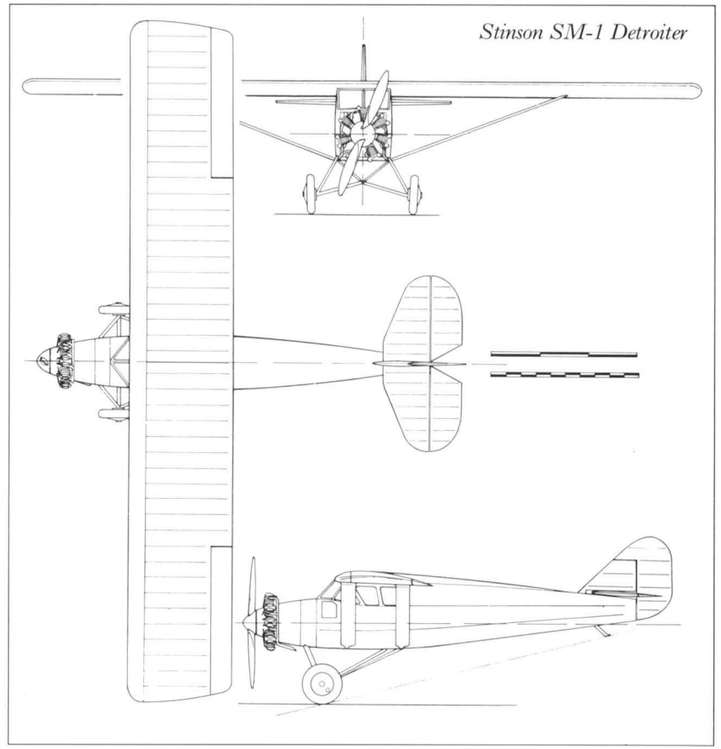
Two days before Schlee and Brock's departure, Paul Redfern had taken off from Brunswick, Georgia, in the first Detroiter NX773 *Port of Brunswick* for a solo nonstop flight to Rio de Janeiro. The point of origin was decided by Howard Coffin, president of the Hudson Motor Car Company and chairman of National Air Transport who was developing a resort island nearby. The SM-1 had been modified to carry 525US gal of fuel which gave an endurance of 52 hours, hardly enough for the 4,600 miles to Rio. Last seen over Ciudad Bolivar, Venezuela, Redfern most likely crashed in the dense jungle of British Guiana and the remains of the *Port of Brunswick* are still to be found.

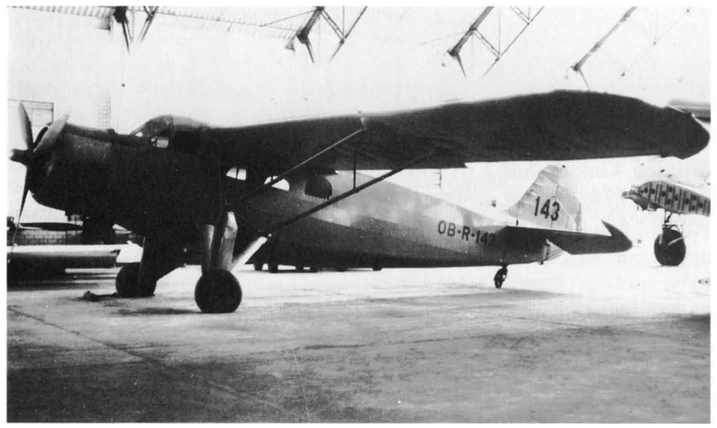
SM-1 Detroiter X-3260 The Adelaide (msn M214). (Davidson-Hudek collection)

American Girl, *the SM-1 (NX1384 msn M207) used by George Haldeman and Ruth Elder for their Atlantic flight in October 1927.* (Davidson-Hudek collection)

The next record attempts made with Detroiters focused on the Atlantic. The *Sir John Carling* left Harbour Grace on 7 September, 1927, out of London, Ontario, bound for London, England, but disappeared without trace along with Irish-born Canadians Terrance B Tully and James V Medcalf. A similar competing attempt to link Windsor, Ontario, with its sister city in England with Detroiter *Royal Windsor* (NC1100 msn M203), flown by C A 'Duke' Schiller and Phillip S Wood was abandoned because of poor weather and the adverse publicity caused by the loss of Tully and Medcalf.

George Haldeman and Ruth Elder in *The American Girl* (NX1384 msn M207) tried to cross the Atlantic on 11-12 October but a ruptured oil line forced them to ditch 360 miles short of the Azores after 29 hours flying. Both flyers were rescued and thus Elder at least became the first woman to attempt to fly the Atlantic and both achieved a record overwater trip of 2,623 miles. Less fortunate were Walter Hinchliffe and Miss Elsie Mackay in the *Endeavor* (X4183 msn M223),





Eight-seat SM-6B NC412M (425hp Wasp). (Stinson)

The ultimate SM-1 Detroiter development, this Faucett F-19 (OB-R-143 msn 27) is believed still preserved at Lima, Peru. (Peter Jary)

The mania continued as *City of Chicago* (NC5189 msn M233) with brothers John and Kenneth Hunter flew 553hr 41min nonstop between 11 June and 4 July, 1930. Three weeks later it was bettered by 94 hours. Although these marathons were of little practical value, they proved the increased reliability of engines and airframes and Stinson benefitted from the enormous publicity.

Production of SM-1s was completed under ATC 16 (November 1927) and the SM-1B was introduced in late 1928 (ATC 2-24, 24 October, 1928, which later covered the SM-1 as well) with minor improvements. Seven SM-1s were redesignated SM-1 Special (ATC 2-174, 16 January, 1930), and the sole SM-1B Special (msn M212) had five seats and a gross weight of 3,597lb (ATC 2-224, 13 June, 1930). A total of seventy-four aircraft were built and, besides record-breaking attempts, many were used by airline operators including Braniff Airways, Delta Air Service, and the Thompson Aeronautical Corporation. Priced at around $12,000, other SM-1s saw service as executive transports.

The SM-1DA (Wright J-5) introduced minor changes and five were built in 1928 (ATC 74, October 1928). One aircraft (NC5900 msn M300) was flown to fifth place in the 1928 Ford Tour by Stinson. At least two (NC9600 and NX9617) were converted to SM-1D-300 configuration with the 300hp Wright J-6-9-300 (R-975) and gross weight 4,300lb (ATC 2-60, 13 April, 1929 and 7 November, 1929).

Only one SM-1DB (NC6580 msn M301) was completed, with an empty weight 90lb greater than that of the SM-1DA (ATC 76, October 1928). Other single-example models were the SM-1DC (Wright J-4B, ATC 77, October 1928), a cargo version with a 1,300lb payload used by International Air Transport, Brownsville, Texas, to haul fish, and the similar SM-1DD (ATC 78, October 1928) with a 20lb extra payload. The designation SM-1D Special (ATC 2-143, 23 October 1929) covered all models with gross weight increased to 4,500lb.

Designed by L M Woolson, the three-seat SM-1DX (X7654 msn M262) was fitted with a 225hp Packard R-980 and, first flown by Woolson and Walter Lees on 19 September, 1928, was the world's first diesel-powered aircraft. Subsequently, it was awarded ATC 2-228 (20 June, 1930).

Developed from the SM-1D-300 by Kenneth Ronan, the SM-1F had the more powerful Wright and a revised tail. After the company's move to Wayne, 26 were built under ATC 136 (29 April, 1929). Two were used in Alaska by McGhee Airways and four shipped to China in May 1929 after the Chinese Ministry of Communications contracted with Stinson to operate a Shanghai–Nanking mail route. The first trip was flown on 8 July, 1929, and service continued sporadically for several months. Some were passed to the China National Aviation Corporation (CNAC) and operated twice weekly on the nine-hour Shanghai–Peking service via Haichow, Tsingtao, and Tientsin. All were reported unserviceable by 1933.

From msn M509, all SM-1Fs were eligible for conversion as seaplanes (SM-1FS) with Edo J or K floats (ATC 212, 24 August, 1929) and one (msn M523) was exported to Canada as CF-AMD.

Shown at the 1929 All-American Aircraft Show, the seven-seat SM-6A was powered by a 420hp Pratt & Whitney Wasp C-1 and, with a 5,000lb gross weight, was intended for passenger or cargo carrying work. Only two were built (ATC 2-89, 3 July, 1929) followed by eleven eight-seat SM-6Bs (ATC 217, 28 August, 1929). Priced at $18,500 initially, this figure was lowered to $15,995 by Cord in 1930.

The last SM-6B was acquired by Elmer Faucett's Compania de Aviación Faucett SA (which had operated seven Detroiters) and used as an experimental model for a considerably enlarged and stronger version. Powered by a 600hp Wasp S1H1-G or an 875hp Hornet S1E3-G, thirty were built at Lima, Peru, between 1934-46 with the designation Stinson-Faucett F-19. Operated by Faucett, the eight-seat F-19 made the first non-stop flight between Lima and Buenos Aires in March 1937, and during the conflict with Ecuador served as a military transport. Affectionately known as *La Cucaracha*, the F-19 remained in service on the Tumbes—Talara route until replaced by Douglas DC-4s in 1964.

Five Detroiters survive in the United States, two in private hands, the SM-1DX at the New England Air Museum, Windsor Locks, Connecticut, the *Pride of Detroit* in the Henry Ford Museum, Detroit, and the *Greater Rockford*, rescued from Greenland in 1968, which was fully restored and placed in the Rockford Museum, Illinois, in June 1988. Three F-19s also remain in Peru.

SM-1

One 220hp Wright J-5C nine-cylinder air-cooled radial engine.

Span 45ft 10in; length 32ft 0in; height 8ft 3in; wing area 292sq ft.

Empty weight 1,970lb; gross weight 3,485lb.

Maximum speed 128mph; cruising speed 105mph; climb 750ft/min; ceiling 14,000ft; range 550 miles (90US gal fuel capacity).

SM-6B

One 420hp Pratt & Whitney Wasp C-1 nine-cylinder air-cooled radial engine.

Span 52ft 8in; length 34ft 4in; height 9ft 8in; wing area 334sq ft.

Weight empty 3,496lb; gross weight 5,350lb.

Maximum speed 148mph; cruising speed 128mph; climb 1,000 ft/min; ceiling 18,000ft; range 575 miles.

Faucett F-19 (Seaplane)

One 600hp Pratt & Whitney Wasp S1H1-G nine-cylinder air-cooled radial engine.

Span 58ft 0in; length 38ft 8in; height 14ft 4in; wing area 435.8sq ft.

Weight empty 5,775lb; gross weight 8,750lb.

Maximum speed 160mph at 8,000ft; cruising speed 135mph at sea level; ceiling 18,000ft.

SM-2, SM-7, SM-8, Model S and Model W Junior

In 1928, William C Naylor designed a three- or four-seat high-wing monoplane, intended for private use, using the Clark Y aerofoil and powered by a 110hp Warner Scarab. First flown that April, the SM-2 Detroiter Junior (later just Junior) was of similar construction to the Detroiter with steel-tube fuselage, wooden wings, and tube and wood-ribbed lifting struts, all fabric covered. Two wing fuel tanks had a capacity of 42US gal and there was a sturdy 'outrigger' undercarriage of wide track.

Forty-two SM-2s were built in 1928 at Northville under ATC 48 (August 1928), the first aircraft to be certificated with the Scarab, and the type distinguished itself in several races that year. The second aircraft (NC5889) was placed third in the National Air Tour, flown by former air mail pilot Randolph Page and another SM-2, flown by Bruce Braun, came sixth. In the Air Derby, George W Hopkins came 11th in Class A, flying 2,939 miles in 34½ hours.

The following year, after the company's move to Wayne, three similar SM-2Ks were built (ATC 2-136, 4 October, 1929) with 100hp Kinner K-5 engines. One of these (msn 1012) was later fitted with a 125hp Kinner B-5 (ATC 2-414, 11 June, 1932).

However, the bulk of the 1929 production run consisted of true four-seaters powered by Wright engines. The SM-2AA had a 165hp R-540 (J-6) and twenty-five were built under ATC 145 (20 May, 1929) with a gross weight of 3,152lb and priced at $8,500. Two were used as engine test-beds, msn

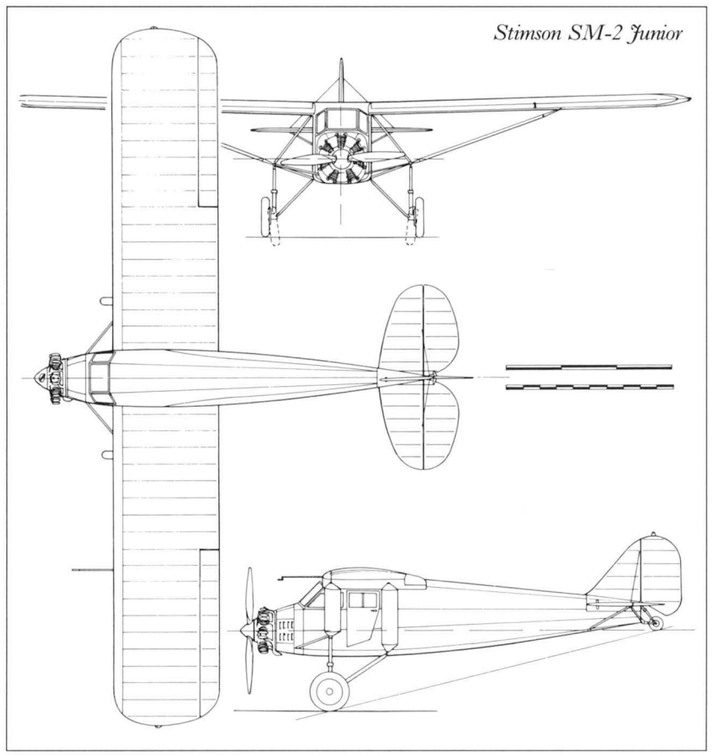
lost over the Atlantic on 13 March, 1928, following a secretive take-off from Cranwell.

In July 1928, Bert 'Fish' Hassell, an American pilot of Swedish descent, and navigator Parker 'Shorty' Cramer set out from Rockford, Illinois, Hassell's hometown, in the 700US gal capacity *Greater Rockford* (NX5408 msn M235). Theirs was a well-planned exercise to fly to Stockholm via the unexplored polar route and six stops were scheduled, including one at Lloyd Camp, a strip prepared by a scientific expedition from Michigan near Søndre Strømfjord, Greenland. Strong winds and dense clouds drove them 200 miles off course and with fuel almost exhausted after 24 hours flying a crash-landing was made 75 miles short of the camp on 19 August. The crew walked for fourteen days before being rescued.

Another 'homeland' flight ended in disaster. The *Green Mountain Boy* (NR7576 – it was painted red!) with Clyde A Lee and John Bochkon, from Wisconsin, sponsored by businessmen of Barre, Vermont, left Harbour Grace on 25 August, 1932, for Oslo but were lost at sea.

Endurance records were established then quickly broken by Detroiters. Eddie Stinson and George Haldeman used X1524 (msn M210) to achieve a new world endurance record of 53hr 36min at Jacksonville, Florida, 28-30 March, 1928. But next year 174 hours in the air was logged by Byron K Newcombe and Roy L Mitchell in *City of Cleveland* (NR5485 msn M239) at Cleveland, using another Detroiter as a refuelling tanker. The same year, Little and Mollop pushed the record to 197hr 30min, again in a Detroiter, then *Billion Dollar City* (NR7218 msn M259) reached 200 hours.

1928-production SM-2 Junior (NC)7398 (Warner Scarab). (Stinson)



1107 (X472H) by Continental Motors for its 165hp A-70 and msn 1046 (9695) with a 170hp Curtiss Challenger.

The thirty-five SM-2ABs (ATC 161, 11 June, 1929) had the 225hp J-5C, were heavier with a fuel capacity of 70US gal, and had a strengthened undercarriage and other minor changes which brought the price to $10,500. One (msn 1047/9699) was used to test the Challenger engine. The SM-2AC (twenty-five built under ATC 194, 9 August 1929) had the 250hp R-760 (J-6-7-225). Both had a 2ft longer, more elegant fuselage and a larger fin and rudder. Edo float-equipped variants of both models were built. The SM- 2ABS (msn 1062) was approved 6 Sep- tember, 1930 (ATC 2-267) and the SM-2ACS (msn 1093) on 23 October, 1929 (ATC 2-143).

More luxurious (and more expensive) were the 1930 production models developed by engineer Kenneth M Ronan. The SM-7A had a 300hp R-975 (J-6) and ten were built (ATC 298, 18 February, 1930). One (NC499Y msn 3100) was converted with Edo Q floats as the SM-7AS (ATC 2-313, 26 December, 1930). Only five SM-7Bs with 300hp Pratt & Whitney Wasp Juniors were completed (ATC 329, 29 June 1930). Some were used by Walter Varney for his Varney Air Service from Oakland to Marysville, California. Two were impressed by the USAAF as L-12As (44-52992,52995).

With the Cord acquisition of Stinson, Lycomings became the preferred powerplant and Ronan made the effort to return the design to a more affordable aircraft. When announced in April 1930, the 215hp Lycoming R-680 powered SM-8A was priced at just $5,775. Coupled with the Junior's roomy and comfortable cabin, forgiving flight characteristics, and a payload over 1,000lb, this made the 1930 production of the SM-8A (230 built under ATC 295, 11 February 1930) more than all other cabin aircraft combined. But there were few exports, except to Canada and Mexico.

Other versions were the SM-8AS (msn 4201) with Edo P floats (ATC 2-301, 15 November, 1930); SM-8A Special (NC425M msn 4014) converted with a 225hp Wright R-760 by Robert W Ellis (ATC 2-461, 8 November, 1933); the SM-8B with a R-760 (five built under ATC 294, 1 February, 1930); and the SM-8D (225hp Packard DR-980), the first approved (ATC 312, 8 April, 1930) diesel-powered civil aircraft. Two were built and priced at $8,995.

The 1931 Junior, the Model S, introduced only minor changes from the SM-8A and despite the poor economic outlook, 113 were built under ATC 423 (12 May, 1931). Many were used by air-taxi and charter operators and at $4,995 (reduced by $400 in 1932) it was undoubtedly a bargain. A few export aircraft were built and three were sold in the United Kingdom. The standard colour scheme was black and red, but some were finished in two-tone green. Other schemes were optional, as were cowling rings, wheel fairings, landing lights and a 73US gal fuel capacity.

Last of the Junior line was the Model W, an updated version of the SM-7A aimed at the wealthy sportsman pilot. Five were built (ATC 435, 14 July, 1931). General Electric used one (NC12144 msn 3053) as an electronic test and research aircraft.

In 1988 two SM-2s, three SM-7s, eighteen SM-8s, and twelve Model S Juniors are registered in the United States.

SM-8A Junior NS-61 of the Bureau of Air Commerce. (A R Krieger)

Junior S NS-12171 operated by the Stae of Illinois. (A R Krieger)

SM-8A Special NC-425M of Robert W Ellis with a Wright R-760 engine. (Gordon S Williams)

SM-2

One 110hp Warner Scarab seven-cylinder air-cooled radial engine.

Span 41ft 5in; length 26ft 3in; height 7ft 4in; wing area 236sq ft.

Weight empty 1,516lb; gross weight 2,500lb.

Maximum speed 106mph; cruising speed 90mph; climb 520ft/min; ceiling 10,000ft; range 425 miles.

Model S

One 215hp Lycoming R-680 nine-cylinder air-cooled radial engine.

Span 42ft 1in; length 28ft 11in; height 8ft 9in; wing area 236sq ft.

Weight empty 2,172lb; gross weight 3,265lb.

Maximum speed 128mph (with speed ring); cruising speed 105mph; climb 750ft/min; ceiling 13,500ft; range 400 miles.

The only known photograph of the SM-3. (E J Pearson collection)

The SM-4 rebuilt as "K" of New Haven (NR9696). (Pratt & Whitney)

SM-3

This designation is believed to have been applied to a four-seat, low-wing cabin monoplane with a tapered gull wing and retractable undercarriage, powered by a 220hp Wright J-5C. Built during winter 1927/28, it was flown once by Stinson who likened its flying characteristics to a brick and it was scrapped shortly after its first flight.

SM-4

This special two-seat endurance aircraft featured a retractable undercarriage, the wheels and struts swinging up and outwards into the high wing which was braced by very wide lifting struts. Powered by a 300hp Wright R-975A, only one aircraft was built in 1929, X9696 *Sally Sovereign* (msn X-10), and used by Stinson and Randolph G Page for an endurance flight over Saginaw, Michigan, which ended with a wheels-up landing at Lake St Clair.

Rebuilt with a fixed undercarriage and a Pratt & Whitney Wasp as *"K" of New Haven* (NR9696) for H G Partridge, the SM-4 was used on an attempted nonstop, refuelled flight from New Haven, Connecticut, to Buenos Aires (7,700 miles) on 31 May, 1930, but engine failure necessitated a landing at Roosevelt Field, New York. On 15 July, a second attempt from Roosevelt Field ended when the aircraft became lost in fog and ran out of fuel 15 miles from Monroe, Georgia. The crew, Randall Enslow, James Garrigan, and Garland Peed, baled out and the aircraft crashed and was destroyed.

SM-5

Possibly a development of the SM-3, this was another low-wing monoplane with a Wright J-5 Whirlwind. One aircraft was registered NX9625 (msn X-11) in March 1929 and was re-engined with a J-6/R-760 by 1 November. On 15 November, Stinson Aircraft requested the registration cancelled 'in as much as we have no idea what engine will next be installed.'

SM-9

In 1930, an experimental four-seat amphibian powered by a 215hp Lycoming R-680 was built (NX414Y msn M-9000) but scrapped following a crash landing.

SM-6000 and Model T

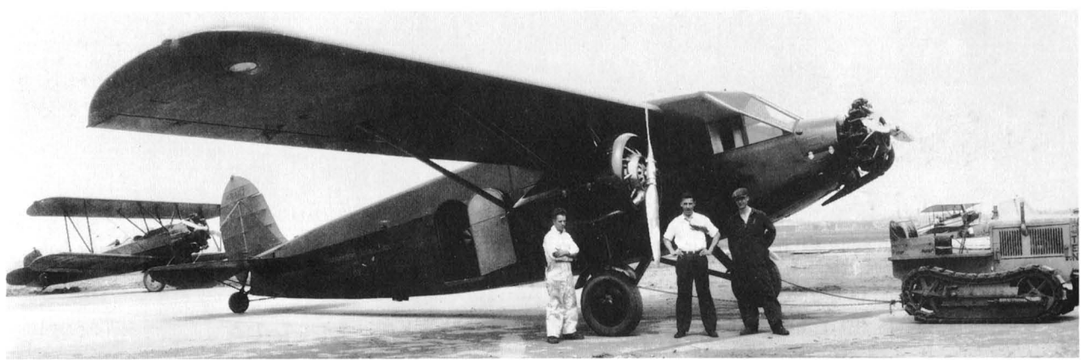
Cord entered the aircraft business in 1928 with the formation of the Corman Aircraft Inc at Connersville, Indiana, (Corman was a contraction of the names of the founder and his associate Lucius B. Manning). The following March, an eight-passenger trimotor, the Corman 3000 (X881N msn 6010) was produced at Dayton, Ohio, powered by three Wright J-5s. The Corman 3000 was designed by Horace E Weihmiller, who earlier had been responsible for the Travel Air 6000. In April, a similar Weihmiller 3000 (X2275 msn 1) was completed but by December this aircraft had been scrapped.

Following the takeover of Stinson by Cord in late 1929, the Corman/Weihmiller designs formed the basis of a new trimotor with Lycoming R-680s which appeared at the All-American Aircraft Show at Detroit in April 1930 as the ten-passenger 'Stinson Airliner'. Priced at $23,500 – well below its trimotor competitors from Ford and Bach – the model attracted considerable interest and eight were ordered by Charles Townsend Ludington (reportedly at the discount price of $18,000) for his New York, Philadelphia, and Washington Airway (The Ludington Line).

Ludington stipulated that the production SM-6000 should be certificated in just 90 days. Such was the level of industry in the days o f the Depression that this target was reached (ATC 335, 10 July, 1930) and the first

During winter 1929, the Corman 3000 (X881N msn 6010) was reworked as the prototype SM-6000 'Stinson Airliner'. (D C Wigton collection)

SM-6000B NC11176 of Transamerican Airlines. (Stephen J Hudek collection)

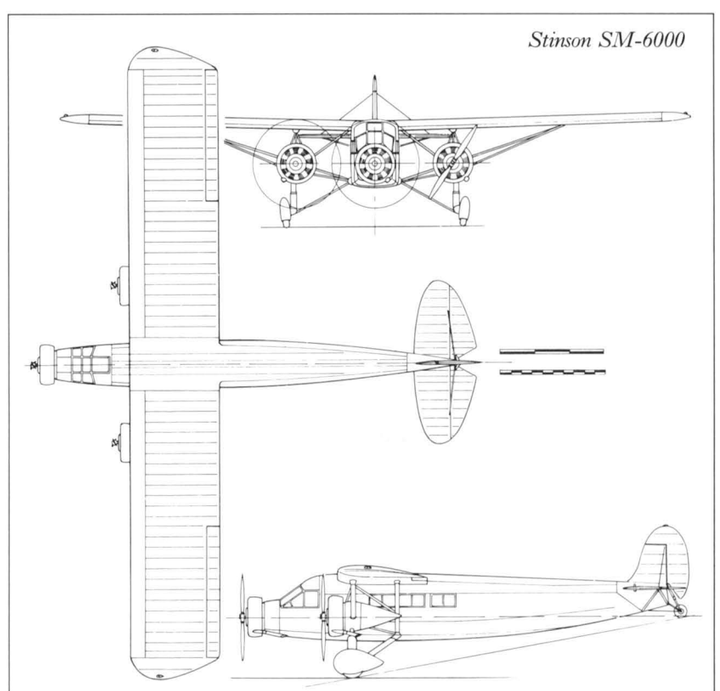


passenger service was flown on 1 September. Ludington promised a departure 'every hour on the hour' for the New York–Washington shuttle (eleven trips a day) with fares only slightly higher than those charged by the railways. Every possible cost saving tactic was used, including taxi-ing on one engine and a pilot who undertook ground tasks. Even the aircraft colour scheme was designed to gain extra payload, it consisted of black and gold, the lightest pigments available.

Construction of the SM-6000 was traditional steel-tube and fabric-covered fuselage and wings except for around the cockpit area where duralumin panels were used. The leading edge of the Göttingen 398 aerofoil was also aluminium-covered as far back as the main spar. The wings housed four fuel tanks for a total capacity of 120US gal. Although certificated for single-pilot operation, a co-pilot's position with dual controls was optional. The cabin seated ten and all the windows could be opened for fresh air. The main entry door was on the starboard side. Standard equipment included an electric starter, battery, generator, navigation lights, fire extinguishers and chrome-plated hardware.

Department of Commerce pilots were impressed with the SM-6000's performance, noting that 'in general there was a very apparent reserve amount of power available', after noting two-engine climbs of 100ft/min. Field performance was also highly rated, the take-off run being 700ft with just 400ft required for landing.

Stinson SM-6000



The SM-6000A (ATC 367, 19 September, 1930) had interior changes to allow the carriage of 225lb of cargo and mail instead of two passengers and an all-cargo configuration was possible. Townend-ring cowlings and large wheel fairings offered a 10mph increase in speed and the fuel capacity was increased to 200US gal. Extra instru-

Model A X11117 on Belleville Lake in 1931. (Harold D Hoekstra)

ments were installed in a lighted panel and a cabin heater was an optional extra. There was no production, but conversions were made from SM-6000s.

Introduced in 1931 for $25,900 (ex-factory), the SM-6000B was similar but featured a washroom/lavatory and forty-two were built under ATC 420 (23 April, 1931), often referred to as the Model T. Early in 1932, the price was lowered to $19,500. The SM-6000B1 was the all-passenger version, allowing just 25lb of baggage for each person, but more popular was the SM-6000B2. This carried eight or nine passengers, the forward seats replaced by bins for up to 350lb of baggage or mail. A right-hand forward door could also be fitted to allow easier loading. Later, the gross weight was increased by 200lb to 8,800lb with approved modifications. Two aircraft were built with special 'club' interiors for executive use.

No less than twenty-eight SM-6000Bs went to Cord's own companies, Century Air Lines and Century Pacific Lines, which operated fourteen each between Cleveland and Detroit and from Chicago to St Louis; and on the San Francisco – San Diego route respectively. When American Airways (through AVCO) took over Cord's airlines, along with Trans-american Airlines (formerly Thompson) in 1932, twenty-eight SM-6000Bs were acquired. Other original customers were Ludington and Pennsylvania Airlines. Subsequent airline operators included Rapid Air Transport Eastern, Air Transport, National Airways, Chicago & Southern Airlines, Delta Air Lines, Los Angeles Airways, Canadian Colonial Airways, and Caribbean-Atlantic Airlines (Caribair).

Retired from airline use with the introduction of the Lockheed 10 Electra, Boeing 247 and Douglas DC-2, the SM-6000s were passed to charter and barnstormer operators. Two were sold to Honduras and others to Mexico and Nicaragua. Postwar, one (N11153 msn 5021) was converted with 300hp engines for crop dusting and re-skinned with metal. Restored by Richard and Nell Rice of Kennett, Missouri, in 1965-66, it has found a home with a museum at Athol, Idaho.

Another survivor (N11170 msn 5023) was abandoned at Manley Hot Springs, Alaska, and in 1970, an eleven-year rebuild of the remains started at Neenah, Wisconsin. Used for joy-riding until 1986, when high liability insurance forced it to be grounded, pilots reported it easy to fly but the claimed cruising speed of 110mph was more like 90mph.

SM-6000B

Three 215hp Lycoming R-680 nine-cylinder air-cooled radial engines.

Span 60ft 0in; length 42ft 10in; height 12ft 0in; wing area 490sq ft.

Weight empty 5,670lb (B1) 5,758lb (B2), gross weight 8,600lb.

Maximum speed 138mph; cruising speed 112mph; climb 1,000ft/min, 10,000ft/30 min; ceiling 14,200ft, range 390 miles.

Model A

An experimental four-seat cabin amphibian with twin fins and rudders on booms, with two 215hp Lycoming R-680s, one Model A (NX11117 msn M-7000) was completed in January 1931. Shown at that year's Detroit Aircraft Show at Detroit City Airport, it was briefly tested from Belleville Lake, near Detroit. However, flying characteristics and performance were poor and it was scrapped following damage in a wheels-up landing.

Model R

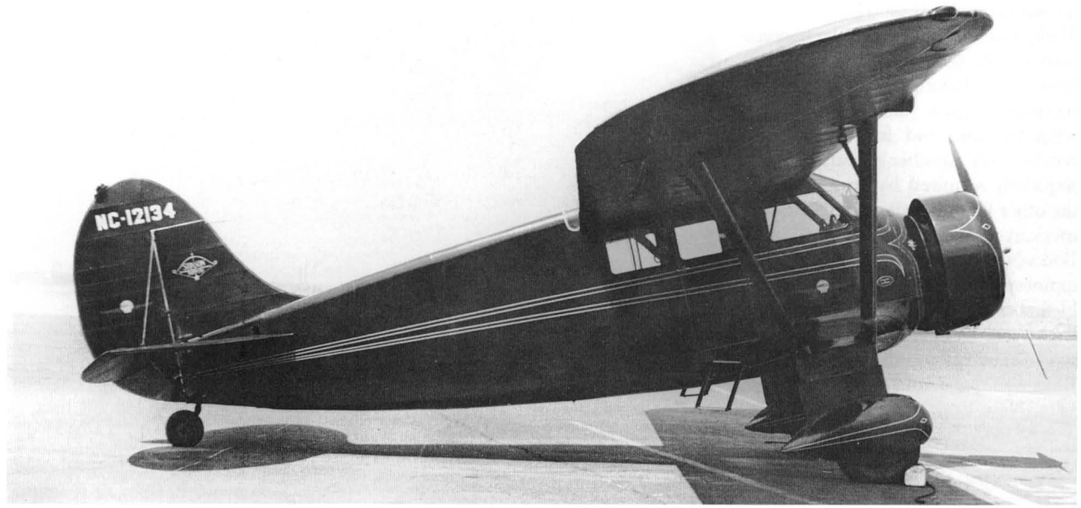
In spring 1931, C R 'Jack' Irvine and Robert W Ayer initiated an extensive redesign of the SM-8A/Model S series. Although the basic fuselage of the Junior was retained, the length was reduced by three feet and the cabin upgraded by stylist Lloyd Skinner. Ayer also adopted the semi-cantilever undercarriage from the Gee Bee Sportsters to replace the Junior's split-axle type and this was attached to a stub wing that also carried the wing bracing struts.

The prototype (X12178 msn 8500) was first flown by Stinson and test pilot Jack Kelly in autumn 1931. On the morning of 25 January, 1932, the Model R was awarded ATC 457 and Stinson left on a sales tour. That evening, at Chicago, Stinson made one more demonstration flight. Shortly after take-off, the fuel supply was exhausted and in the ensuing forced landing attempt the prototype crashed, fatally injuring Stinson.

Faced with one of the leanest economic periods in aviation, Stinson Aircraft produced thirty more Model Rs. One famous customer was comedian Ben Lyon and another (msn 8510 NC12157) was used by Mobiloil and based in Belgium. Subsequently, this aircraft was sold as OO-HCS, later G-AFUW. Standard Oil operated one (NC447M msn 8521) of the three Model R-2s (ATC 489, 27 June, 1932) built with 240hp R-680-BA engines.

From the outset, the Model R had been designed with a retractable undercarriage version in mind. The R-1 model, based on the R, was not pro- ceeded with, thus the R-3 (based on the R-2) introduced this then-novel feature. The prototype (X449M msn 8600) was tested by Ayer but because of the high-wing layout, the manual mechanical system — the wheels went into under-fuselage recesses — did not provide the expected performance advantage. A total of five were built (ATC 493, 1 September, 1932) and some were converted to R-3S standard with a 245hp R-680-6 (ATC 539, 17 May, 1934). No Model Rs are known to survive.

One 215hp Lycoming R-680 nine-cylinder air-cooled radial engine.



Model R NC12134. (Bill Wildprett)

Model M NR12123 was nicknamed the Silver Star. (Peter M Bowers collection)

Span 43ft 3in; length 26ft 1in; height 8ft 9in; wing area 235sq ft.

Weight empty 2,225lb; gross weight 3,325lb.

Maximum speed 130mph; cruising speed 110mph; climb 675ft/min; ceiling 12,500ft; range 450 miles.

R-3

One 240hp Lycoming R-680BA nine-cylinder air-cooled radial engine.

Weight empty 2,290lb; gross weight 3,500lb.

Maximum speed 138mph; cruising speed 118mph; climb 600ft/min; ceiling 12,500ft.

Model M

Inspired by the Northrop Gamma, the Model M was an all-metal four-seat executive transport with a 300hp Wright R-760. Built in 1932, the sole prototype (NR12123 msn 32000) was operated briefly by W D Gann, Scientific Service Inc, New York.

Model U

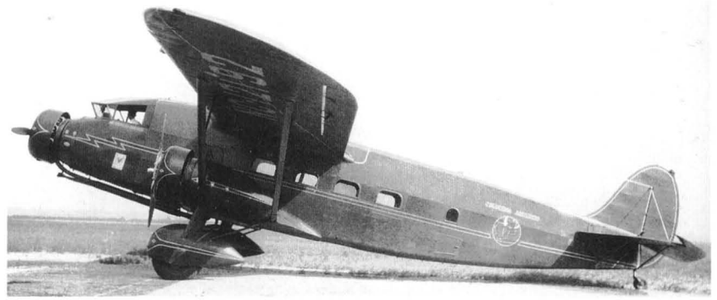
Designed as an SM-6000 replacement by chief engineer Art Saxon (formerly with Corman) and project engineer Sam Benson, the Model U was larger overall with three 240hp Lycoming R-680-BA engines. Additional lift was, as usual, gained from the wing struts plus 54sq ft stub wings between the fuselage and the engine nacelles which also offered alternative baggage and cargo space. The prototype (X432M msn 9000) was first shown at the Detroit show in April 1932 and priced at $22,900, later reduced to $19,500.

Thanks to Cord's ownership of American Airways, the airline ordered seventeen ten-passenger Model Us, primarily for use on its Colonial Air

Transport division's routes out of New York. The twenty-one production aircraft (ATC 484, 12 May, 1932) differed in having revised engine mountings, new undercarriage and wing bracing, and forward inclined windshields. Another aircraft was subsequently acquired by American and the other four aircraft went to Transamerican Airlines (later American); Iloilo-Negros Air Express in the Philippines; and to William Randolph Hearst of the San Francisco *Examiner* (eight-seat club version). The prototype was certified under ATC 2-413 (8 June, 1932) and sold to Lion Airways, Islip, New York.

The load distribution was evidently more critical than the Model T (SM-6000B) and it tended to be tail heavy. This gave the Model U a reputation for unsteadiness in rough air and passengers were frequently sick. The brakes were also found ineffective, after American almost lost one aircraft in a taxi-ing accident, new brakes were installed, made by Cord-owned Columbia Axel Company. Later, the co-pilot's position was replaced by radio equipment.

One Model U-1 (X12129 msn 9014) was built for evaluation by Eastern Air Transport with 285hp Wright R-760-Els (ATC 2-437, 7 February, 1933) but this was sold the following year.



Ex-American Airlines Model U NC12192 (9018) operated by Columbia Airlines. (A R Krieger)

Another experimental Model U was I-12132 (msn 9013) fitted with a Benson-designed lightweight tail made of dural, in an attempt to reduce the tail heaviness and increase cargo capacity. Chief pilot Owen H Pinaire reported vibrations in the tail during the first flight on 8 February, 1933, and was joined on the second flight that day by Benson and Saxon. All three were killed when the aircraft crashed in a field several miles from Wayne. A second dural-tailed Model U was tested and it was discovered that severe tail flutter developed in a moderate dive, thus production resumed with the earlier welded-tube, fabric-covered tails.

Several of the American Airways aircraft were passed to Columbia Airlines, who used them on a Chicago—St Louis service, and to Mayflower Airlines of Boston. The Hearst machine was sold to Aerovías Nacionales de Costa Rica and subsequently used by TACA. Another went to Panama and two more to Mexico.

Three 240hp Lycoming R-680BA nine-cylinder air-cooled radial engines.

Span 66ft 2in; length 45ft 3in; height 12ft 6in; stub-wing span 14ft 3in; main wing area 460sq ft; stub-wing area 54sq ft.

Weight empty 6,300lb; gross eight 9,400lb

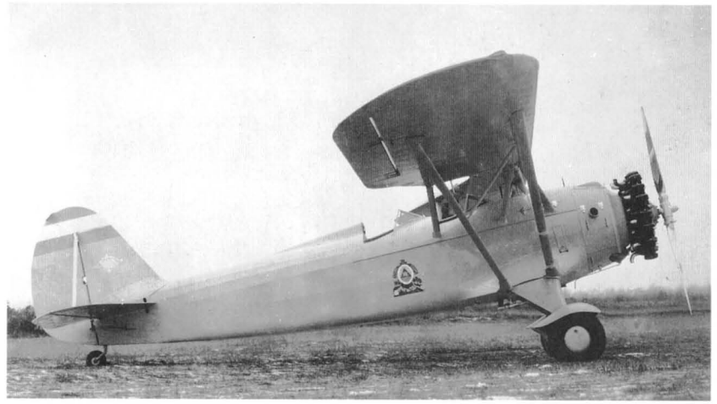
Maximum speed 145mph; cruising speed 123mph; climb 850ft/min; ceiling 14,000ft; range 440-500 miles (160US gal fuel capacity).

Model O

In 1933, Lowell Yerex, the founder of TACA, visited Stinson with a commission to buy trainers and counter-insurgency aircraft for the Honduran Air Force. Using a modified SR wing and tail, Robert L Hall designed a tandem two-seat, high-wing monoplane powered by a 220hp Lycoming R-680-4 which could run on low (58) octane fuel. Two fixed machine-guns could be carried, along with a flexible gun for the gunner/observer in the rear cockpit. One Type A-3 bomb rack could also be quickly installed.

After only a few weeks of work, the prototype (X13817) was first flown in May 1933 and three were ordered by Honduras. At least five more were built under ATC 520 (9 November, 1933) and other exports were one to Brazil, one to Argentina and three to China. G Hall Roosevelt, brother-in-law of the President negotiated with William Mara, vice-president of Stinson to acquire one hundred Model Os for Spain in 1938. However, because of the arms embargo this did not prove possible. The prototype was sold to orchestra leader Wayne King as a fast personal transport and survived until 1946 as a trainer at Glendale, California.

Ex-American Airlines Model U NC12195 (9021) operated by Texas Air Freights Inc. (Stephen J Hudek collection)



One of three Model Os built for the Honduran Air Force. (Stinson)

Reliant SR-5 (Lycoming R-680-4) NC13834 (msn 9202A). (Stinson)

One 225hp Lycoming R-680-B6 or R-680-4 nine-cylinder air-cooled radial engine

Span 39ft 11in; length 27ft 8in; height 8ft 0in; wing area 215sq ft.

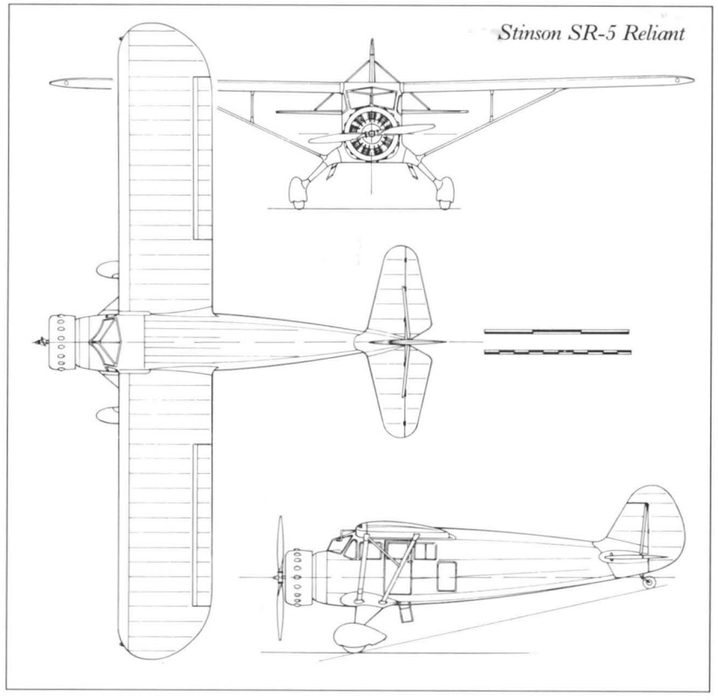
Weight empty 1,907lb; gross weight 2,617lb.

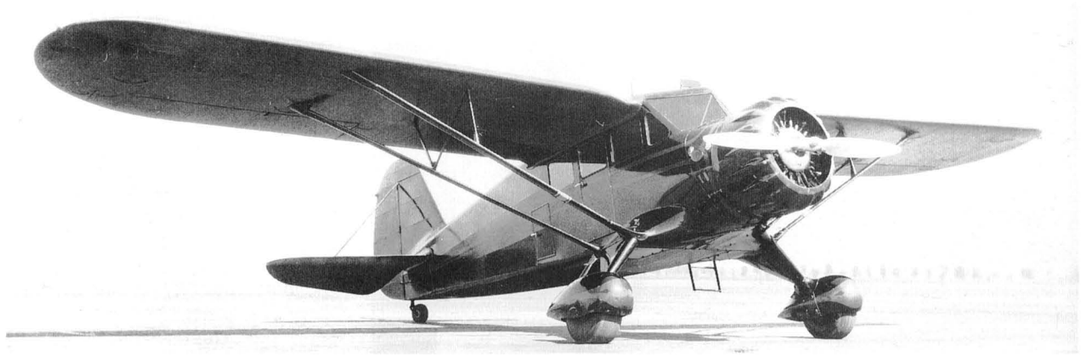
Maximum speed 136mph; cruising speed 122mph; climb 1,100ft/min; ceiling 16,000ft; range 450 miles.

SR Reliant (Straight-Wing Series)

Although the Model R-3 had not been a success, the basic redesign of the Junior was sound. What was required was a less costly version and therefore Irvine produced the SR Reliant, announced in May 1933 at just $3,995. The new aircraft retained most of the features of its predecessor, including the R-680 engine, but featured a new cantilever fixed undercarriage and other detail refinements.

By September, the SR was outselling all other two/six-seat types com-





One of four Reliant SR-6Bs (Lycoming R-680-B5). (Bob McLarren)

An early production Reliant SR (msn 8712) still active on floats in Alaska in 1981. (John Wegg)

bined and eighty-nine were completed that year (ATC 510, 29 June, 1933). An Edo P-3300 float version was also approved and the SR also found a ready overseas market with exports to Canada, Mexico, Czechoslovakia, United Kingdom (msn 8779 G-ACSV), Brazil (msn 8772/ PP-IAC), and China. A nationwide Stinson Air Cab Service was offered by Reliant (and Junior) owners who belonged to the Stinson Air Cab Operators Association. They also operated flying schools with the slogan 'learn to fly in the airplane you will buy'. In Alaska, two SRs were operated by Alaska Airways and Wien respectively, fitted with skis in winter.

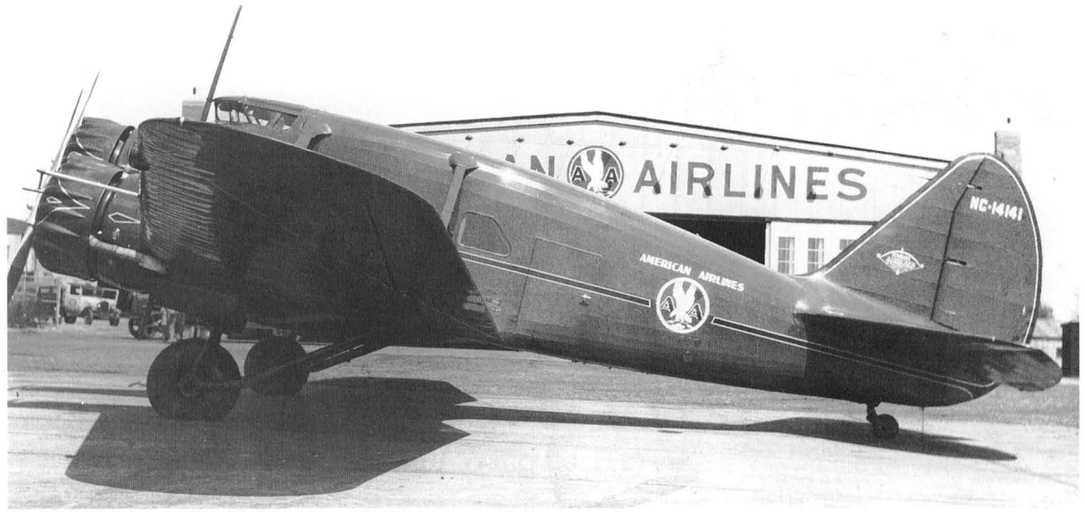
Other early SR models were the SR Special (msn 8788) with an R-680BA (ATC 2-471), 28 February, 1934); the SR-1 with a 240 hp R-680-2, two built (ATC 513, 5 August, 1933) of which one (msn 8900/NC-13485) was converted to an SR-1 Special with an R-680-B4 for Lucius B Manning (ATC 2-496, 31 December, 1934); the sole SR-2 (msn 8910) with an R-680-7; two SR-3s (msn 8921/8922) for the Mexican Army with revised tailplane and controls (ATC 513, 18 December, 1933); and two SR-4s with 250hp Wright R-760-Es (ATC 519, 23 October, 1933).

The principal 1934 model was the SR-5A with 245hp R-680-6, an improved cabin and cowling, V-shaped windscreen, a redesigned shorter-span wing with reduced chord at the roots to

Reliant SR-5A (Lycoming R-680-6) N13936. (A R Krieger)

give slight 'gull' effect, and Selectiv-Glide flaps. The standard SR-5 was similar but lacked flaps and had a 240hp R-680-4. Both were built under ATC 530 (5 April, 1934), fourteen SR-5s and seventy SR-5As. Included in the latter total were two for the Coast Guard and Navy as the RQ-1 (V149) and the XR3Q-1 (BuA 9718) respectively. Two SR-5As were impressed as L-12s in 1942 (44-52994,52996).

As before there were many variants. Two SR-5 Specials (msn 9200A/ 9201A) had flaps (ATC 2-492, 4 October, 1934); three others approved on the same day had the R-680-6 (ATC 2-494) and a fourth (msn 9297A) was fitted with Edo floats (ATC 2-491) for the Maine Department of Forestry. The New York Times News Syndicate purchased a SR-5A Special (msn 9349A) with an R-680-6 (ATC 2-511, 25 July, 1935); the five SR-5Cs had the R-680-5 and were operated by Wyoming Air Service and Northwest Airlines; the sole SR-5D (msn 9211) had an R-680 and a smaller tail unit and was



The first Model A in service with American Airlines. (Bill Wildprett)

exported to China (ATC 2-493, 4 October, 1934); and the SR- 5B was a projected version with an R-680-2 but not built.

The SR-5E was based on the SR-5A but had less standard features and threfore a lower cost. Forty were built under ATC 537 (5 May, 1934). More powerful were the two SR-5Fs (ATC 550, 10 August, 1934) with a 250hp R-760-E and 285hp R-760-El respectively. The latter (NC14156) was *Texaco 19* flown regularly by 'Duke' Jernigan.

Last of the straight-wing models was the SR-6, powered by a 245hp R-680-6 which reverted to the longer SR-type wing combined with the modifications introduced on the SR-5. The prototype (msn 9400/X14199) was designated SR-5X Reliant III and in 1935 forty-two SR-6s and five SR-6As (R-680-B4) were built under ATC 580 (23 July, 1935). Also included in the same ATC were four SR-6Bs with 260hp R-680-B5s, and a four/five-seat cabin but the SR-6C (R-680-B2) was not produced. The SR-6X (X15139) was SR-6A msn 9641 fitted with a new gull wing for the SR-7 series.

Around twenty straight-wing Reliants remain active, all but one in the United States.

SR

One 215hp Lycoming R-680 nine-cylinder air-cooled radial engine.

Span 43ft 3in; length 27ft 0in; height 8ft 5in; wing area 235sq ft.

Weight empty 2,070lb; gross weight 3,155lb.

Maximum speed (wheel spats) 130mph; cruising speed 115mph; climb 750ft/min; ceiling 14,000ft; range 460 miles.

SR-5A

One 245hp Lycoming R-680-6 nine-cylinder air-cooled radial engine.

Span 41ft 0in; length 27ft 3in; height 8ft 5in; wing area 230sq ft.

Weight empty 2,315lb; gross weight 3,390lb.

Maximum speed 135mph; cruising speed 120mph; climb 900ft/min; ceiling 15,500ft; range 420-645 miles.

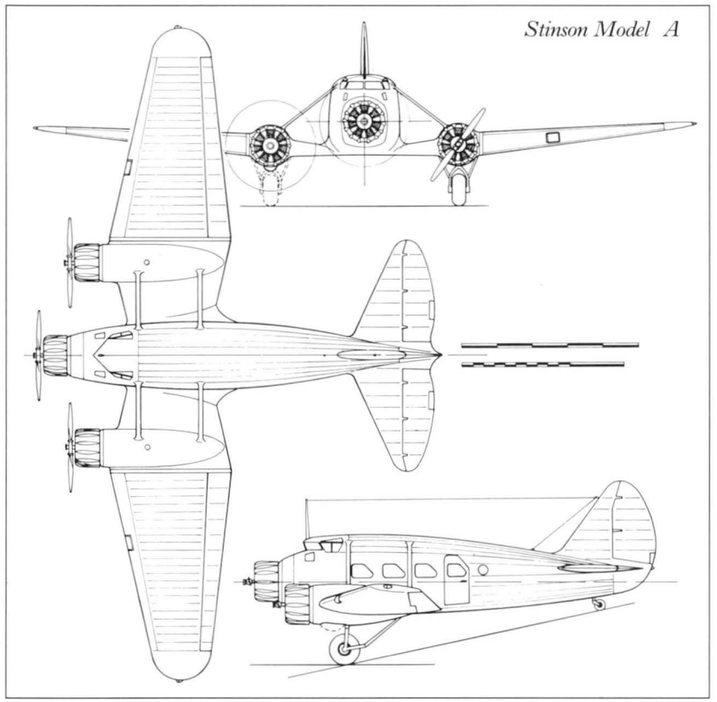
Model A

In November 1933, Stinson announced the Model A trimotor, designed by chief engineer Robert W Ayer, to meet an American Airways' requirement for an eight-passenger feederliner costing less than $35,000 with a take-off run of 800ft or less and the ability to clear a 50ft obstacle in 1,200 ft. A wide fuselage seated passengers three-abreast in the two rear rows and two abreast in front and the cockpit accommodated two crew. The wing was an unusual patented double-taper design, low-mounted and strut-braced. Both were of conventional tube and fabric construction, except the centre section of the wing was metal covered. Three 245hp R-680-B6 engines were installed.

The electrically-operated trailing-edge flaps and retractable undercarriage was designed by one of Cord's auto experts, actuated by a common power source through a gear-shift transmission. All new US airliners had retractable undercarriages but pilots still tended to forget about this new feature and it was decided to leave the wheels uncovered and partly exposed after retraction to minimise damage in the event of a wheels-up landing. In the rear of the wing engine nacelles were lockers for mail and baggage and a 500lb baggage bin was located in the rear fuselage, along with a lavatory. Fuel capacity was 160US gal (later increased to 220US gal).

American's Ralph DeVore flew the prototype (X14141 msn 9100) for the first time on 27 April, 1934, although Ayer had previously made over forty test 'hops' to check the field length with a 9,400lb load, 900lb over the design estimate. Five months later the prototype was delivered to American for in-service evaluation which led to numerous modifications, including the installation of a fire-retardent interior. This delayed deliveries of its fifteen aircraft for several months.

Thus, Delta Air Lines, with three aircraft, was the first airline to put the Model A into service, in July 1935 on the Charleston–Atlanta–Dallas route. The second batch of five went to Central Airlines which operated them between Washington, DC and Detroit via Cleveland, Akron, and Pittsburgh. Both airlines flew with two cockpit crew, limiting the passenger load to



eight. Most production aircraft had the more powerful R-680-5 engines.

Advertised as 'America's fastest Tri-Motor', the Model A was in service with Delta less than a month when NC14599 (msn 9103) was lost near Gilmer, Texas. Investigation revealed that a blade of the port propeller failed at the flange and cut through the fuselage disabling the pilot Andy Dixon. Despite fire from the runaway engine the co-pilot, Herbert Bulkely, managed a controlled descent but misjudged the distance and crashed with the loss of all four on board. Hamilton fixed-pitch propellers replaced the Smith-Lycoming controllable airscrews until Hamilton produced a two-position propeller a few months later.

American started Model A service in late 1935 on the Detroit – Chicago route. The wisdom of leaving the wheels partially exposed was confirmed on at least one occasion when American's president, C R Smith, flew to Washington to give a speech. The pilot forgot to lower the undercarriage, but after Smith had emerged, with a witty remark about absent-minded pilots, the undercarriage was selected down, the aircraft rose up, and after a change of propellers, returned to New York the same afternoon.

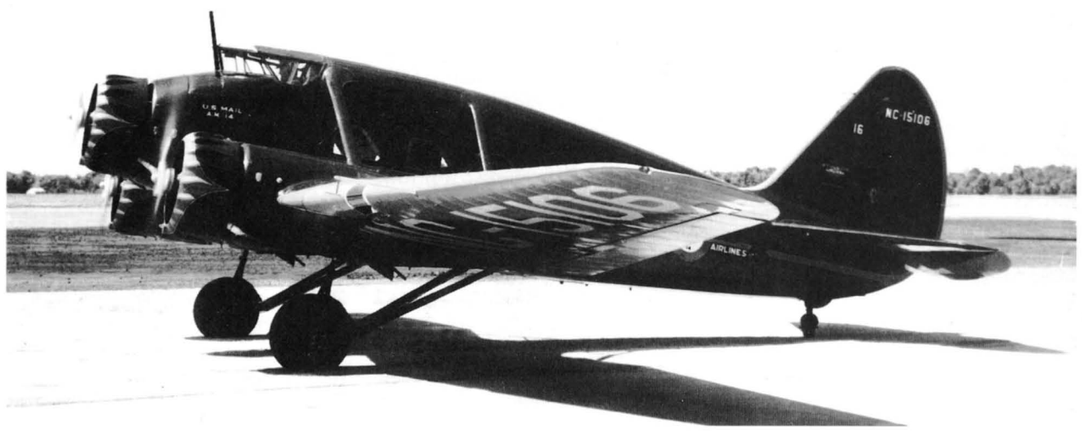
In April 1936, the first of four was delivered to Airlines of Australia to replace Avro-built Fokkers (the Avro Ten). On its inaugural flight the *City of Lismore*, piloted by H D Bowyer on loan from American, broke the existing commercial record handsomely by completing the 510-mile Sydney – Brisbane trip in 2hr 45min. Although no fault of the aircraft, two were lost in crashes within the first year of operations.

The Model A continued to attract misfortune. An American Airlines aircraft operating a New York – Buffalo mail flight crashed during a snowstorm on 1 April, 1936, and the following month the prototype (still with American) was lost in a refuelling accident. Delta withdrew its remaining aircraft in March 1937, after its second Model A had been destroyed in a non-fatal landing accident after a test flight. American did the same thing a year later.

Of the remainder of the thirty production aircraft (ATC 556, 25 September, 1934) two were delivered as executive aircraft and one went to China in 1936. Three later went to Mexico, and one each to Panama and Costa Rica.

Because of a shortage of Lycoming spares, the two surviving Australian aircraft, now with Australian National Airways, were converted to twin configuration with 600hp Pratt & Whitney R-1340-S3H1 engines. Tata Air Lines (later Air-India) obtained five aircraft

Central Airlines Model A NC15106.
(D C Wigton collection)



Texaco's Reliant SR-9F NC2215.
(A R Krieger)

in 1941 and kept them in service until 1944.

Postwar, Korean National Airlines began operation in 1947 with 'Stinson Trimotors' and possibly these were Model As. No less than eight aircraft found their way to Alaska and one (N15165 msn 9125) was rescued after being abandoned near Nenana following a wheels-up landing in 1947. After a seven-year restoration it flew again in 1979. In 1988, it was returned to Alaska for preservation by the Aviation Heritage Museum, Anchorage.

Three 260hp Lycoming R-680-5 nine-cylinder air-cooled radial engines.
Span 60ft 0in; length 36ft 10in; height 11ft 6in; wing area 500sq ft.
Weight empty 7,200lb; gross weight 10,200lb.
Maximum speed 180mph; cruising speed 163mph at 5,000ft; climb 980ft/min; ceiling 17,000ft; range 490 miles (220US gal fuel capacity)

Model L

This four-seat low-wing project with a 225hp Lycoming R-680-B6, retractable undercarriage and tapered wing, was designed by Robert L Hall as a SR-5 replacement. One prototype (X14199) was tested by Hall in August/September 1934 but work was abandoned as it was considered too difficult to handle by the average pilot. The registration was applied to the SR-5X. In an effort to stop rumours, a press release was issued describing the aircraft as a tandem two-seat military 'Pursuit Trainer'. No photographs of the completed Model L are thought to exist.

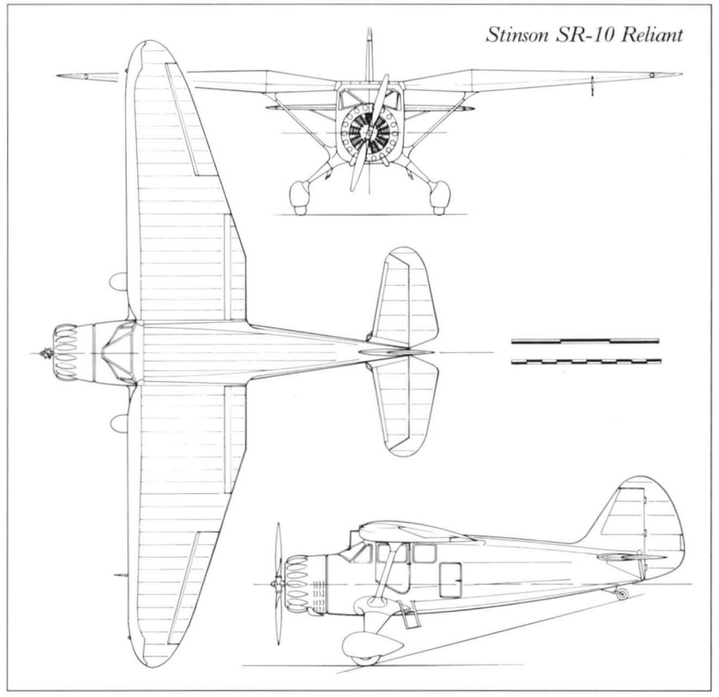
SR Reliant (Gull-Wing Series)

Because of the effectiveness of Ayer's double-tapered wing used on the Model A trimotor, a similar sesquispar wing was engineered by Hall and Harold D Hoekstra and mated to the fuselage of the SR-6 with a single bracing strut on either side. The result was both efficient and graceful.

Satisfactory testing was undertaken with an SR-6A fitted with the new wing (SR-6X X15139). However, the first production SR-7B crashed on 8 January, 1936, following failure to recover from a normal spin test. Fortunately, pilots G C 'Cy' Younglove and Jack Kelly were able to bale out successfully. Attributed to asymmetric wing lift, the problem was corrected by adding spoiler strips to the wing leading edges.

Three models were certified under ATC 594 (13 February, 1936), the most numerous (47) being the SR-7B with a 225hp R-680-B6. The SR-7A (R-680-B4) was not built and only three SR-7Cs with an R-680-B5 were completed. Four were exported to Australia, two to Uruguay for military use, and others to Germany, Britain, Brazil, and the Philippines.

The two SR-8As with R-680-B4s



Royal Navy AT-19 Reliant FK815. (Convair)

(ATC 608, 28 May, 1936) had only minor changes but the SR-8B (R-680-B6) introduced a five-seat cabin which necessitated revised wingtips and control rigging to eliminate the tendency to enter a flat spin. Of the fifty-seven built, one was converted to SR-8C standard with an R-680-B5 to join twenty others. Two Wright-powered versions were also produced, eleven SR-8Ds (285hp R-760-E1) and thirty-five SR-8Es (350hp R-760-E2) both under ATC 609 (3 June, 1936). Multi-purpose models, suffixed 'M', featured two doors on the starboard side to ease loading of bulky cargo. Nine SR-8Bs were ordered by the Bureau of Commerce, many went to Canada, three to Norway, two to Iceland, and one each to Mexico and Venezuela. One of the Norwegian aircraft (LN-BAR msn 9706) was used during the 1937 Antarctic expedition led by Lars Christensen, flown by Viggo Widerøe. Four SR-8Bs were impressed as UC-81s, two SR-8Cs and UC-81Ls, and one SR-8EM as a UC-81B. One SR-8B was impressed by the RAAF as A38-1 and used by No.37 Squadron.

For the following year, the SR-9 was offered in the usual number of variants, the major differences being a larger cowling, a moulded instead of a flat-panel windshield, and a 4in increase in wing span. The Lycoming R-680-powered models were certificated under ATC 621 (30 December, 1936), the SR-9A (B4) was not built, but there were thirty-five SR-9Bs (B6) and sixty-five SR-9Cs (B5). The Wright-powered SR-9D (R-760-E1, twenty-two built) and SR-9E (R-760-E2, forty-three built) were under ATC 625 (2 February, 1937) and another thirty-four SR-9Fs with a 450hp Pratt & Whitney Wasp Junior were covered by ATC 640 (26 May, 1937). Multi-mission, seaplane 'S', and deluxe 'D' models, the latter with Hamilton Standard controllable propellers, were also available, and prices ranged from $9,500 to the $18,000 SR-9F. One SR-9F (PP-TCM) was unsuccessfully tested with two-step amphibious floats and delivered with standard Edo 39-4000 floats. Other export destinations included Belgium, China, Austria, Italy, Romania, Cuba (for the Army), the Philippines, and Argentina.

One of Stinson's proudest selling points was that none of its licensed aircraft had ever suffered a structural failure. However, on 1 August, 1937, Arold Widerøe and his four passengers were killed when an SR-9ESM (LN-EAI msn 5211) lost a wing over Oslo harbour. The cause was quickly discovered. Because of a tooling error there was serious misalignment on the wing/strut attachment which increased stress to the point of failure. Modification kits were produced for high-time aircraft but in the meantime flying continued. A few weeks later a similar failure occurred to an Imperial Oil SR-9DM (CF-BEQ) but pilot T M 'Pat' Reid was able to land safely. However, on 12 January, 1938, a second fatal accident befell an SR-9EM of General Airways (CF-BEI msn 5212) near Hudson, Ontario, and all unmodified aircraft were immediately grounded. Although the SR-9s were quickly returned to service, the company suffered from loss of confidence for some years.

Another serious Reliant loss, although no fault of the aircraft, occurred on 29 January, 1938, when the one flown by Jerry Vultee crashed into Mt Wilson, Arizona, during a snowstorm. The designer and his wife were killed.

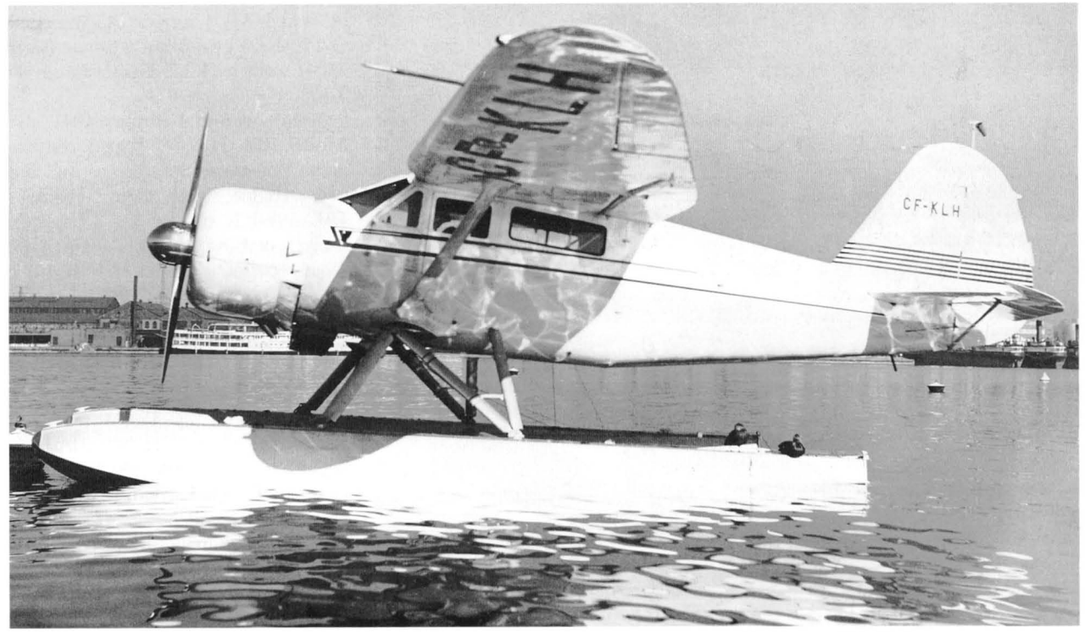
During 1942, there were several impressments of SR-9s, two SR-9Bs to UC-81Ns, three SR-9Cs as UC-81Cs, three SR-9Ds as UC-81Gs, ten SR-9Es as UC-81Js, one SR-9EM as a UC-81M, and four SR-9Fs as UC-81Es. Four SR-9s also served at 'Little Norway' (Toronto Island) during 1940-43.

The Guiberson Diesel Engine Co used SR-9BM NX17192 (msn 5162) to test fly its 310hp A-1020 seven-cylinder air-cooled radial engine from February 1942. Trials were successful but a lack of engines (supplied to the Army for tanks) prevented further development.

The final refinement of the Reliant series appeared in 1938 and project engineer Gordon Israel aimed at reducing drag with a new cowling and exhaust system, retractable cabin steps, and flat windshield panels. Produced in two series, the 5800 for 1938 and the 5900 for 1939, the SR-10 continued the tradition of different suffixes for engine selection. The SR-10A was not produced, but under ATC 678 (29 April, 1938) there was one SR-10B (R-680-D6) which was exported to Britain (msn 5819/G-AFHB), forty-six SR-10Cs (R-680-D5), twelve SR-10Gs (R-680-E1), and eleven SR-10Js (R-680-E3). The SR-10H (R-680-E2) was not built.

All-red SR-10Cs were used by All American Aviation for ground air mail pick up services using Dr Lytle S Adams' trailing grapple device to over sixty isolated communities in six northeastern states for ten years from May 1939. Another (OK-ATZ) spent part of the war as the personal aircraft of General Ferdinand Catlos, Slovak Minister of Defence. Five SR-10Cs were impressed as UC-81Ks and two SR-10Gs as UC-81As.

All Wright-powered models, the SR-10D (R-760-E1), SR-10E (R-760-E2), and SR-10K (R-975-E3) were built under ATC 679 (12 May, 1938).



Bushman CF-KLH, a metalised Reliant produced in Canada (Larry Milberry)

The three SR-10Ds went to Brazil; there were twenty-one SR-10Es including one (msn 5924) for the Argentine Navy; and two SR-10Ks (msn 5905/5906) for the New York Police. One SR-10E was impressed as a UC-81H.

Eighteen SR-10Fs (Wasp Junior) were completed under ATC 685 (22 June, 1938) with eight impressed as UC-81Fs. Another (msn 5910/NX-2311) was operated in civil marks as the XC-81D to test glider pick-up techniques.

The civil Reliant line ended in 1941, but the following July, the first of 500 three-seat military versions of the SR-10J was flown. Ordered for Britain under lend-lease as an instrument trainer, the V-77 (Vultee sequence) received the military designation AT-19 (42-46640/46889, 43-43964/44213). The majority went to the Fleet Air Arm in the serial ranges FB523/845 and FK814/FL163. The Reliant I (AT-19) was a five-seat transport, the Reliant II (AT-19A) a three-seat instrument and navigator trainer, the Reliant III (AT-19B) an observation and photographic survey version, and the Reliant IV (AT-19C) a cargo aircraft. A few went to Canada and others were taken over by the US Navy (BuA 30481/30542) which also evaluated one V-77B, converted in 1945 from the V-77 prototype (NX39414 msn 501) with a 450hp Pratt & Whitney R-985-AN6.

Postwar, around 350 were re-turned to the United States and many were civilianised under ATC 774 (26 November, 1946), either as luxury transports or utility models. In 1960, a metalised version with all wood and fabric replaced was introduced in Canada as the Bushman. Over one hundred V-77s and about seventy prewar gull-wing Reliants are still active, mostly in the United States.

SR-7B

One 225hp Lycoming R-680-B6 nine-cylinder air-cooled radial engine.

Span 41ft 7in; length 27ft 2in; height 8ft 6in; wing area 256.5sq ft.

Weight empty 2,310lb; gross weight 3,600lb.

Maximum speed 146mph; cruising speed 138.5mph at 3,000ft; climb 725ft/min; ceiling 12,300ft; range 475 miles.

SR-9D

One 285hp Wright Whirlwind R-760-El seven-cylinder air-cooled radial engine.

Length 28ft 1in (otherwise as SR-7B).

Weight empty 2,600lb; gross weight 4,050lb.

Maximum speed 152mph; cruising speed 140mph; climb 900ft/min; ceiling 14,500ft; range 630 miles (78US gal fuel capacity).

SR-10F

One 400hp Pratt & Whitney Wasp Junior SB nine-cylinder air-cooled radial engine.

Length 27ft 11in (otherwise as SR-7B).

Weight empty 3,045lb; gross weight 4,650lb.

Maximum speed 170mph; cruising speed 177mph; climb 1,330ft/min; ceiling 21,000ft; range 680-850 miles (124US gal fuel capacity).

Voyager (Prewar Models)

In 1938, Stinson decided to enter the true lightplane market with a completely new design powered by an equally new 75hp Lycoming. The basic layout was conceived by Lewis E Reisner and Maurice A Mills at the University of Detroit, aided by William A Mara and consultant Peter Altman. Suitability for the mass market was essential and the HW-75 featured a NACA 4412 aerofoil with slotted flaps and fixed leading-edge slots which made it almost completely spin resistant.

Construction was straightforward. The two wing panels were made up of spruce spars with metal ribs and lead-

HW-*75 Voyager F-BGQO (ex-NC21189) was later sold in the United Kingdom as G-BCUM.* (John Wegg)

HW-75 Voyager NC21161 (msn 7846). (Burton Kemp)

ing edge, covered with fabric. The fuselage and tail were fabric-covered steel-tube but the tailplane was an all-wood structure. A third seat was mounted sideways in the compact cabin.

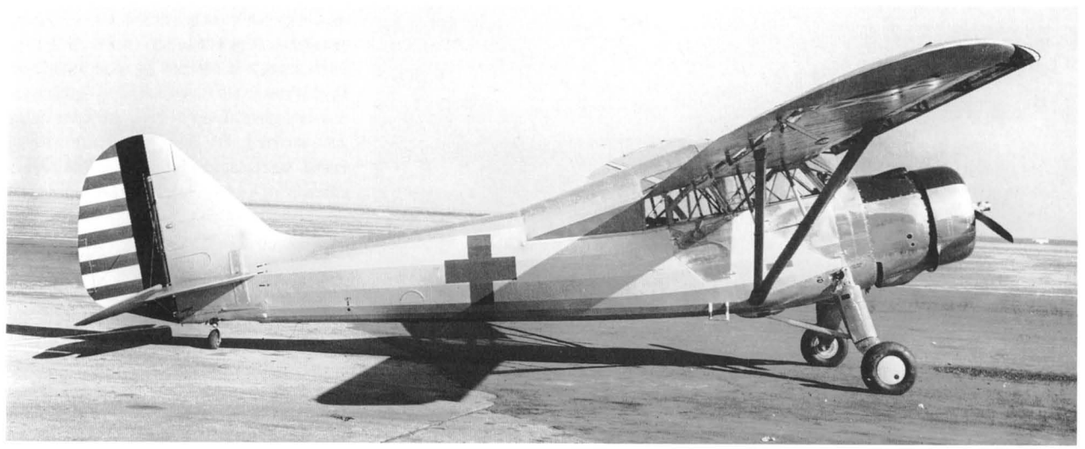
Because of delays with the new engine, the prototype (NX21121 msn 7000) was first flown by Albert H 'Al' Schramm on 3 February, 1939, with a 50hp Lycoming. Although it handled well, it was obvious that a more powerful engine was needed and it was decided to substitute a 75hp Continental A75-3. After two months of tests, the HW-75 received ATC 709 on 20 May, 1939, and priced at $2,995, was shown at the New York World's Fair as the Stinson 105, the number referring to the advertised maximum speed. Orders poured in and production quickly reached three aircraft a day. A total of 275 were built, including twenty for the RCAF which were ferried across the border in civil markings, before production switched to the HW-80 (Model 10) with an 80hp A80-6.

Most of the 260 HW-80s were completed at Nashville, Tennessee, following transfer of production from Wayne in May 1940. France ordered 600, but only a handful were delivered before the Armistice in 1940. Six were acquired by the USAAC as YO-54s (41-143/148) with a Continental O-170-1 for evaluation and one (msn 7504) went to RAE Farnborough as X1050.

Announced in February 1941, the Model 10A (HW-90) introduced the name Voyager to the series as well as a new engine, the 90hp Franklin 4AC-199-E3. Except for a six-inch shorter cowling, other changes were mostly cosmetic and 500 were built (ATC 738, 3 March, 1941). Understandably, there were few exports but one rancher in Brazil ordered twenty-seven to patrol his herds! Extensive use was made of all models during the war by the Civil Air Patrol and the USAAC ordered eight 10As as AT-19As (42-88666/88673) with Franklin O-200-1 engines but these were redesignated L-9As. The L-9B (AT-19B) designation covered twelve impressments. Also under the same type certificate was the Model 10B with the long-awaited 75hp Lycoming GO-145-E-3. However, engine delays

Model 10 Voyager NC26244. (Burton Kemp)

Model 10A Voyager NC31597 (msn 7012). (Burton Kemp)



An O-49B Vigilant at Moffett Field, California, on 6 December, 1941. (Peter M Bowers collection)

continued to plague the programme and there was only one prototype converted from the first 10A (NC27714 msn 7761).

In March 1940, the Army held a competition at Wright Field for a less costly aircraft than the Model 74. Stinson entered a stock Model 10 with a plexiglass roof and although it rated highly it performed poorly in heavy mud, as did the other six designs. Following these trials, A P Fontaine designed the Model 75B (Vultee sequence number) with two tandem seats and a 100hp Lycoming O-235. First flown by Schramm on 19 June, the prototype (NX27711 msn 6001) was fitted with a 120hp Franklin 6AC-264-F2 in August. That same month, production of the Voyager was moved back to Wayne to make room for Vigilant and Vengeance production. Although the Model 75 was not built in quantity it was developed into the successful Model 76 'Flying Jeep'.

About forty HW-75/80s survive, including one in the United Kingdom (G-BMSA), and four times that many Model 10/10As.

HW-75

One 75hp Continental A-75-3 four-cylinder air-cooled engine.

Span 34ft 0in; length 22ft 2in; height 6ft 6in; wing area 155sq ft.

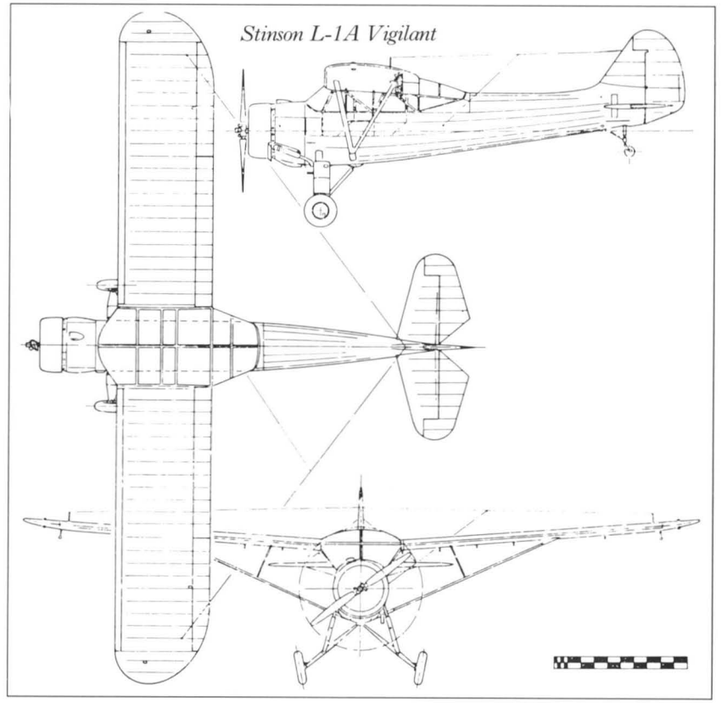
Weight empty 923lb; gross weight 1,580lb.

Maximum speed 105mph; cruising speed 100mph; climb 430ft/min at sea level; ceiling 10,500ft; range 350 miles. (20US gal fuel capacity).

Model 74 (Vultee) O-49/L-1 Vigilant

Inspired by the appearance of the Fieseler Storch, the USAAC issued a specification for a similar short-range two/three-seat STOL liaison/observation aircraft on 23 August, 1938. No less than twelve manufacturers submitted proposals by the end of the following February. The Stinson (Vultee) entry was the Model 74, designed by A P Fontaine. Predictably, it followed the lines of the German design closely and incorporated many of the same high-lift devices to achieve the required performance. Full-span Handley Page automatic slots were fitted to the leading edge of the wing, with pilot-operated slotted-flaps on the trailing edge and a good downward view was obtained with outward sloping cabin transparencies.

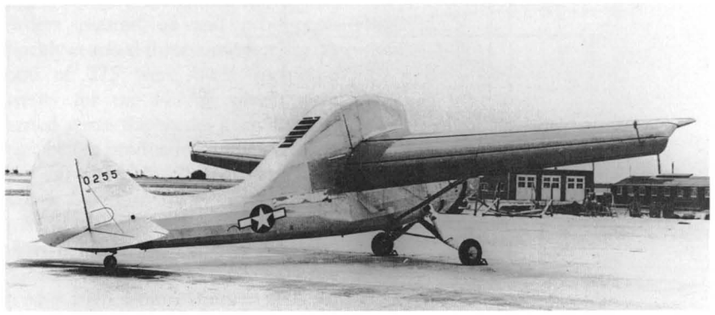
An order for one hundred O-49-ST Vigilants (40-192/291) was placed on 20 September, 1939, although the Army also ordered prototypes from Bellanca and Ryan as back-ups. Fitted with a 295hp Lycoming R-680-9, the prototype O-49 was first flown on 15



L-14A 41-19022 landing at Fort George Wainwright, Washington, on 3 March, 1943. (Peter M Bowers)

July, 1940, by Al Schramm at Nashville. Short-field capability was outstanding, with flights into and out of a 200ft circle possible and roll-out could be as little as 30ft. Further contracts were received for another forty-two O-49s (40-3101/3142) and, later, one hundred and eighty-two O-49As (41-18900/19081) with a 13in fuselage extension, 24-volt instead of a 12-volt electrical system, and increased gross weight. Four aircraft were adapted for ambulance duties as O-49Bs. On 8 April, 1942, the three versions were redesignated L-1-VW, L-1A-VW, and L-1B-VW respectively, after a brief period when they were referred to as L-49s.

L-1 N63230 (ex-40-3102) owned by Tallmantz Aviation, Santa Ana, California. (John Wegg collection)



Dow Chemical-built wing fitted to L-1 40-255 for boundary layer research. (Peter M Bowers collection)

Most saw service with National Guard squadrons, including some overseas and a small number of USAAF aircraft reached Britain. Two were converted to normal seating for use by Gen Dwight D Eisenhower. Several modifications were introduced as follows: L-1C, one hundred and thirteen conversions from L-1As with a loading hatch for a stretcher in the upper fuselage; L-1D, twenty-one modified from L-1As to train pilots in glider pick-up techniques; L-1E, seven converted from L1s with ambulance interiors, twin Edo amphibious floats, winterization camouflage paint, and hoisting hooks to facilitate lifting aboard vessels; L-1F, the original L-1C plus four other L-1As with Edo floats, ambulance interiors, and hoisting hooks; and a small number converted for target control as CQ-2s. The L-1T was a glider-towing version of the L-1 (two or three gliders). One L-1 (40-255) was used for boundary layer control research with a new wing built by Dow Chemical Co. A hump over the cockpit housed a blower which drew in air from the wing induction slot.

The RAF was to have received around a hundred O-49s as Vigilant IAs but most of these were taken over by the USAAC after Pearl Harbor and only fourteen were delivered (BZ100/110 range and HL429/432). Of these, four were damaged in transit and were only fit for use as spares. Rejected by the RAF as an air observation post aircraft, they were consigned for communications use. A further six (HK925/930) were transferred from the USAAF to the RAF in North Africa.

Although agile, the Vigilant suffered from a weak undercarriage, high fuel consumption, and maintenance problems, thus the Army turned to less costly solutions such as the L-5 and really lightweight aircraft from Aeronca, Piper, and Taylorcraft.

A Limited Type Certificate (LTC-26-2, 17 November, 1947) was obtained by Executive Airlines Inc, Cleveland, Ohio, but there apparently was little civil interest. One RAF example (HL432) was sold to Prince Bernhard of the Netherlands as PH-PBD, and today there are four examples in the United States – two held in museums.

O-49

One 295hp Lycoming R-680-9 nine-cylinder air-cooled radial engine.

Span 50ft 11in; length 34ft 3in, height 10ft 2in; wing area 329sq ft.

Weight empty 2,583lb; gross weight 3,315lb.

Maximum speed 122mph at sea level; climb 10,000ft/24.5 min; service ceiling 20,000ft; range 280 miles (52US gal fuel capacity).

Model 76 (Vultee) O-62/L-5, OY Sentinel ('Flying Jeep')

Further development by Fontaine of the Model 75, the tandem-seat military version of the Model 10 Voyager, resulted in the heavier Model 76 Sentinel with a larger fuselage and considerably higher operating weights yet the same 34ft span wing (of all-wood construction, as was the tail, to save strategic materials). The cabin was glazed aft and the enlarged side windows sloped outwards to improve vision, and a fuel tank was installed in each wing root instead of only on the right as in the Model 10.

The prototype (NX27772 msn 76-1) was fitted with a 175hp Lycoming and first flown by Schramm at Wayne on 28 June, 1941. An almost fatal spin test revealed that the full-span leading-edge slots provided asymmetric lift depending on direction of rotation and led to an uncontrollable flat spin. The problem was solved by using half-span slots, as on the Model 10, and slightly larger tail surfaces.

The result was a viceless and exceptional STOL aircraft with a capability of operating from and to 50ft in 630ft and orders for 3,608 followed from the Army for the following versions.

O-62-ST, 185hp O-435-1, 12-volt electrical system, 275 built (42-14798/15072), redesignated L-5 during production. A further 1,538 (42- 98036/99573) produced as the L-5-VU and L-5-VW. In 1962, any surviving aircraft were designated U-19A-VW.

L-5B-VW, right-side downward opening hatch aft of observer's door in deeper rectangular fuselage to enable loading of stretcher or 200lb of cargo, and provision for floats, 730 built from 1944 (42-99574/99753, 44-16703/17252).

USAAF L-5-VW 42-14879 (82nd production aircraft). (Convair)

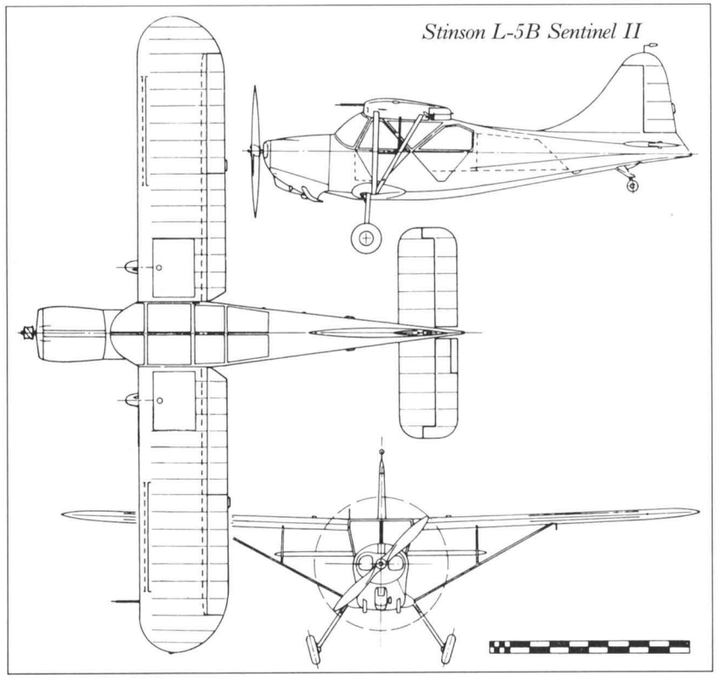
L-5C-VW, similar to L-5B with a K-20 camera installed, 200 built (44-17253/17452).

L-5D-VW, conversions to L-5C standard made from L-5s in service.

L-5E-VW, as L-5C but STOL capability was enhanced with 15-degree drooped ailerons operating in conjuction with the flaps. The L-5E-1 had larger brakes; 750 built (44-17453/18202).

XL-5F-VW, one aircraft only con-

OY-2 03877 Nasty Break # V *of VMO-6 over North Korea in 1951.* (US Navy)



US Coast Guard OY-1 42-14870. (Cmdr Jess Barrow collection)

verted from an L-5B (44-17103) with a 24-volt electrical system and a different radio installation.

L-5G-VW, as XL-5F with a 190hp O-435-11, controllable-pitch propeller, radio changes, and maximum weight increases; 115 built (45-34911/35025) with another 785 cancelled.

Production ceased in November 1945, with 3,608 serials allocated. However, USAAF documents state that a total of 3,590 aircraft was delivered with the discrepancy in the L-5 and L-5E batches. In addition, 900 more aircraft on order were cancelled. The designation L-5A applied to a version with a 24-volt electrical system but all were cancelled. However, this change appeared on some later production aircraft.

Some 306 L-5/B/Es were transferred to the Navy/Marines as the OY-1 with new serials (BuA 02747/02788, 03862/04020, 60460/60507, 75159/75182, 120442/120474) and there were a further 152 transfers without renumbering. In December 1948, all OY-1s with a 24-volt electrical system were redesignated OY-2s. The OY Sentinel was used to establish direct support Marine observation squadrons and the final combat service of the OY-2 was with VMO-6 from August 1950 until April 1952 in Korea.

The RAF took delivery of forty L-5s (Sentinel I, KJ368/407) and sixty L-5Bs (Sentinel II, KJ408/467) for use in Burma by No.194 Squadron. One USAAF aircraft (42-99129) was loaned to the RAAF and another was interned in Switzerland with the serial A-96.

Undoubtedly the most widely used Allied utility aircraft, the Sentinel became known as the 'Flying Jeep' for its ability to go almost anywhere. Used widely in all theatres for communications, air observation, and casualty evacuation, some Marine OY-1s mounted a bazooka on the wing struts.

In 1948, NACA Langley Field modified L-5E 44-17939 with a five-blade paddle propeller driven at 1,000 rpm by an engine geared down in a ratio of 2.8 to 1, and a muffled exhaust. Noise was reduced from 99 decibels to 66 (a reduction of 90 per cent) but the extra weight made it an impractical conversion as a low-flying 'stealth' reconnaissance aircraft.

With the outbreak of the conflict in Korea, the L-5 was returned to service in its former roles. The USAF officially retired the type in 1953, but four years later acquired one additional L-5G (57-6278) as a glider tug for the Air Force Academy, it was redesignated U-19B-VW in 1962.

At least one was used by the Indonesian Air Force and larger quantities were supplied to the air forces of Ethiopia, Greece, Japan, Republic of Korea, Mexico, the Philippines, Thailand, and Italy. Large numbers from the last source were passed to the Aero-club d'Italia in 1954. The other major civil user of the Sentinel outside the United States was India, with over 200 registered.

In the USA the Sentinel was certified under TCu 764 (17 December, 1945) and the remaining inventory of aircraft and spares at Wayne acquired by Sentinel Aircraft Inc, Dexter, Michigan. Possibly, further production was undertaken using the spares supply.

Several hundred were civilianised and Clevenger Aircraft converted several to biplanes for crop dusting from 1955 with the 220hp Continental W-670-16, clipped top wing and lower wing from a Piper Cub. Today, over one hundred and fifty L-5s of various types remain active in the United States and there are a few others still registered in Canada and overseas.

L-5

One 190 hp Lycoming O-435-A six-cylinder air-cooled opposed engine.

Span 34ft 0in; length 24ft 1in; height 8ft 11$^{1}/_{2}$ in; wing area 155sq ft.

Weight empty 1,472lb; gross weight 2,185lb.

Maximum speed 129mph, cruising speed 115mph; climb 975ft/min; ceiling 15,800ft; range 390 miles (36US gal fuel capacity).

OY-2

One 190hp Lycoming O-435-11 six cylinder air-cooled opposed engine.

Weight empty 1,600lb; gross weight 2,265lb.

Maximum speed 126.5mph at sea level; climb 900ft/min; ceiling 15,600ft; range 357 miles.

Model 108 (Convair) Voyager

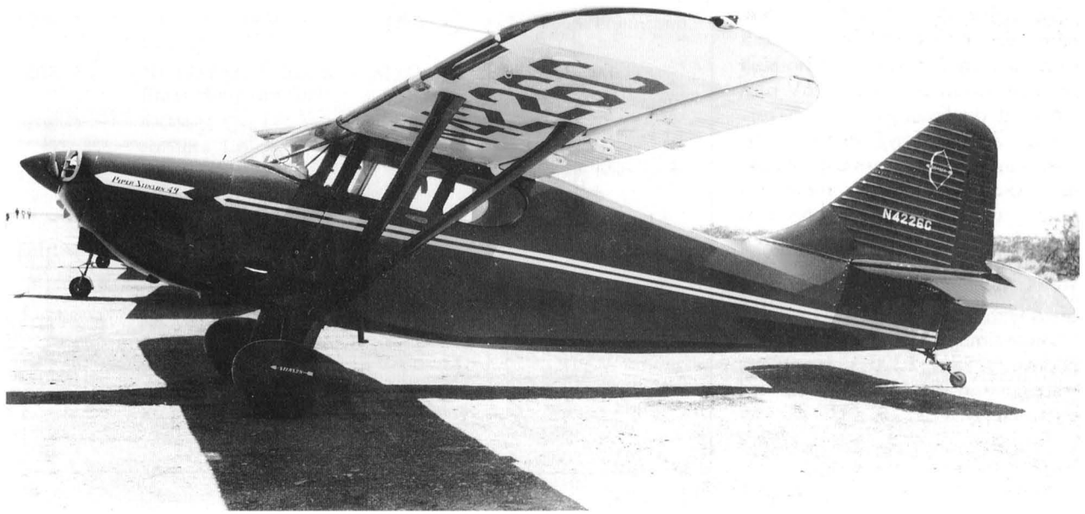
With an end to hostilities in sight, the Stinson Division of Convair turned its thoughts to the postwar civil market and chief engineer B J Bernie Simons designed a four-seat Voyager based on the prewar model. The same wing was retained but the fuselage, built of steel-tube and fabric-covered, was lengthened by 2ft to permit a larger cabin. The prototype (NX31519) first flew on 1 December, 1944, with a 125hp Lycoming.

Clevenger L-5 N63094 (Continental W-670-16). (A R Krieger)

Unsatisfied with the performance, a 150hp Franklin 6A4-150-B3 engine was installed and, with a new metal-covered tail, and tailplane mounted distinctively on the lower part of the fin, the Model 108 was announced in August 1945 as the Voyager 150. With claimed operating costs of two cents per mile, demand was high and 742 were built in 1946 under TC 767 (19 July, 1946) with -B31, -B3, or B4 engines. A slightly improved Model 108-1 was introduced in 1947 (1,508 built) with an outside baggage door and a new control wheel shape. This was followed by the 108-2 in May 1948 with the 165hp 6A4-165-B3 or B4 engine (1,250 built). Both types could be operated on floats (with auxiliary fin) or skis and were available in a Flying Station Wagon version with mahogany trim and a strengthened floor and removable rear seats to allow up to 600lb of cargo to be carried.

A single-strut layout and a taller fin to improve stability was tested in mid-1947 (by NX8563K) but only the latter feature was adopted for the 108-3 which also had fuel capacity increased from 40US gal to 50US gal and structural changes to allow for a higher gross weight. The Model 108-3 was also introduced in 1948, and by June the 5,000th postwar Voyager had been completed. But production then ceased because the industry entered a decline caused by over production and the Model 108-4 remained a proposal with a geared, higher-powered Franklin engine.

At the end of the year, the Stinson Division was sold to Piper, including 200 unsold Voyagers parked at Willow



Model 108-3 Voyager (N4226C msn 108-5226) marked as the 'Piper Stinson 49'. (John Wegg collection)

One of eighteen Model 108-3 Voyagers used by the Spanish Air Force as L.2s. (John Wegg collection)

Run. Another 125 Voyagers were built from existing parts under the Piper-Stinson label to make up a run of 1,760, Model 108-3s, and a total of 5,260 Model 108s. Some of the last aircraft were completed with smaller, Piper-designed tails as the dies for the 'big tail' had already been scrapped. On 27 April, 1949, Piper approved Stinson Division to handle the sales of the remaining aircraft.

Most Voyagers remained in private hands, but several were flown by bush operators and small airlines. In 1956, one aircraft (N9270K) was used by Goodyear to test ultra-low-pressure 'Terra-Tires' and the Spanish Air Force received eighteen 108-3s under the designation L.2. Some Voyagers received metal coverings from the late 1950s as 'All metal Stinson 108s'.

All rights to the Model 108 were eventually sold to Univair Aircraft Corp of Aurora, Colorado, who built the sole Model 108-5 (N5576V msn 108-5001, duplicating in error, the earlier msn 5001 built by Stinson) in 1963 from some of the extensive spare parts they had acquired. The 108-5 was fitted with a 180hp Franklin 6A-335-B1 engine and the modification was approved for all 108-3s on 16 March, 1964. Many Voyagers have since been fitted with Lycoming O-435 engines.

As testimony to its ruggedness and popularity, over 2,300 Voyagers are still active in the United States and elsewhere.

Model 108-3 Voyager

One 165 hp Franklin 6A4-165-B3 or B4 six-cylinder air-cooled engine.

Span 34ft 0in; length 25ft 3in; height 7ft 0in; wing area 155sq ft.

Weight empty 1,294lb; gross weight 2,400lb.

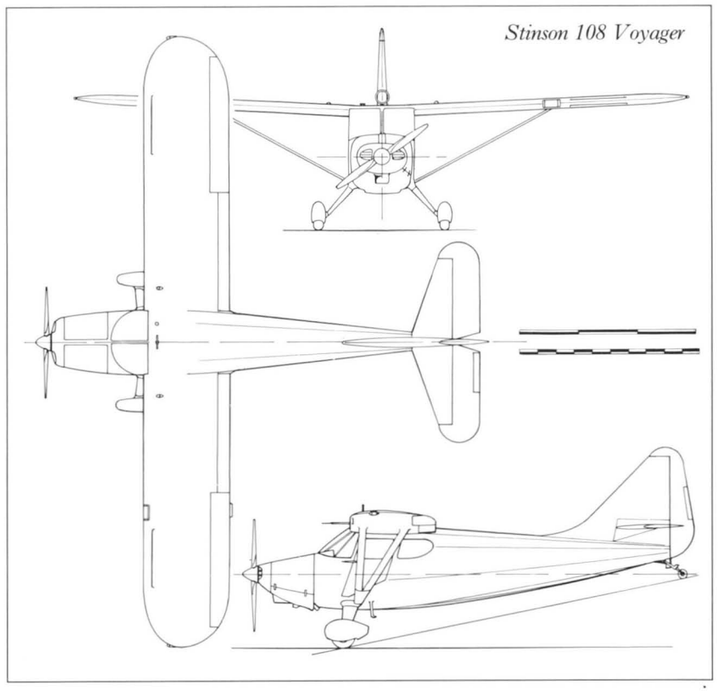
Maximum speed 133mph; cruising speed 125mph at 5,000ft; climb 580 ft/min; ceiling 14,000ft; range 554 miles (50US gal fuel capacity).

Stinson Aircraft Production, Selected Types

SB-1

(Based on available documentation)

msn	
–	Detroiter prototype, built 1925
10	C2762 Wayco Air Services
20	C3597 Florida Airways
30	C881 Horace Dodge
1	NC872 Northwest Airways (s/n given by Northwest)
2	NC873 Northwest Airways
3	NC874 Northwest Airways
4	– G H Wilkins
5	G H Wilkins, NC5262 Wien Alaska Airways
60	NS-5 Dept of Commerce
70	C-CAFW Patricia Airways *Miss Toronto*
80	NC36 Dodgeson Motor Co, Detroit
90	NC2707 Wise Birds Club, Detroit
102	NC3588 Continental Motor Co, Detroit
103	NC3707/C-CAGF/C-CANI Purple Label Airways



104	NC3708/C-CAJC Patricia Airways	
106	NC3036 Midwest Aircraft, Indianapolis	
107	NC2763 Wayco Air Services	
108	NC2779 Boston Airport Corp	
111	NC3795 Boston Airport Corp	
112	NC1419 Vance Air Services, Gt Falls, Montana	
113	NC3123 Jones Flying Corp, Old Orchard Beach, Maine.	
114	NC877 Geo Weis, Alaskan Airways	
115	NC1621 H H Linn, Airplane Co, Morris, NY	
116	NC1429 Harry S Hilliker, Buffalo, NY	
117	NC1381 Westchester Airways, Rye, NY	
201-B	NC3050 F H Taylor, Watertown, NY	

SM-1 Series Detroiter

(Based on available documentation)

Msn		
M200	1	NX773 Paul Redfern *Port of Brunswick*
M201	1	NC857 Wayco Air Services, Brock & Schlee *Pride of Detroit*
M202	1	Tully & Medcalf *Sir John Carling*
M203	1	C1100 Shiller & Wood, 4473 *Royal Windsor*
M205	1	NC1370 Wise Birds Club, Detroit
M205A	1	NC101 A W Shaw Co, Chicago
M206	1	NC1449 A H Kudner, Chicago
M207	1	NC1384 Haldeman & Elder *American Girl*
M208	1	NC1631 Gray Goose Airlines, Chicago
M209	1	NC1517 Harry H Culver, Culver City, California
M210	1	X1524 Edward A Stinson (endurance flight)
M211	1	NC1929 Braniff Airways
M212	1B	Special NC3348 Special Manning & Co (E L Cord)
M213	1	NC3347 D A McIntyre, Tulsa, Oklahoma
M214	1	NC3260 Lewis G Salomon, NY
M215	1	NC3349 Tropical Airways, Clearwater, Florida
M216	1	NC3350 Bror Dahlberg, Chicago; Delta Air Service
M217	1	NC3694 Furniture Capital Air Services, Grand Rapids, Michigan.
M218	1	NC3695 to s/n M228/ NC4728
M219	1/1 Special	NC3647 Modern Airway Transport, Blue Island, Illinois
M220	1B	NC3696 Thompson Aero Co
M221	1	NC5305 Thompson Aero Co
M222	1	NC4185 Beardsley & Piper, Chicago
M223	1	X4183 Hinchliffe & Mackay *Endeavor*
M224	1/1 Special	NC4827 General Aviation Syracuse, NY
M225	1	NC4606 W I Edwards, Houston, Texas
M226	1	NC4679 Packard Electric, Warren, Ohio
M227	1	NC4583 North American Airways, Appleton, Wisconsin
M228	1	NC4728 Texas Air Transport
M229	1	NC5325 Wayne Flying Service, Fort Wayne, Indiana
M230	1B	NC6868 Thompson Aero Co
M231	1	NC4876 Pilot Laboratory, Brooklyn, NY
M232	1	NC5139 Harry E Bovay, Memphis, Tennessee
M233	1	NC5198; N Hurd, Chicago: Hunter Bros *City of Chicago*
M234	1/1 Special	NC5361
M235	1	NX5408 *Greater Rockford*
M236	1	NC5326 N Hurd, Chicago
M237	1	NC5403 N Hurd, Chicago
M238	1	NC5471Air Associates, NY
M239	1	NC5485 Stewart Aircraft
M240	1	NT5639 Stinson Aircraft
M241	1B	NC5676 Thompson Aero Co
M242	1	NC5679 SKF Service, Lansing, Michigan
M243	1	NC5675 F H Taylor, Watertown, NY
M244	1	NC5683
M245	1	NC5684 Cedar Rapids Airways, Cedar Rapids, Iowa
M246	1	X-BACE T Gonzalez Pacheco, Mexico
M247	1	NC5886 Becker Roofing, Milwaukee, Wisconsin
M248	1	NC5887 Geo Haldeman
M249	1/1 Special	NC5993 Tex Lagrune, Kansas City
M250	1/1 Special	NC6657 Sparks-Withington, Jackson, Mississippi
M251	1/1	Special NC6763 Universal Aviation
M252	1B	NC6827 Thompson Aero
M253	1B	NC6764 Thompson Aero
M254	1B	NC6828 Thompson Aero
M255	1/1 Special	NC686 Woods Bros, Lincoln, Nebraska
M256	1	NT7024 Faucett, Lima, Peru
M257	1	NT7025 Faucett, Lima, Peru
M258	1	NC7127 Independence Air Transport, Kansas
M259	1	NC7218 International Air Transport, Brownsville, Texas
M260	1B	NC7168 Northern Air Lines
M261	1	NC7576 Bellstrom & Thomas, Negaunee, Michigan
M262	1	NX7654 Packard Motor Co, Detroit (Diesel tests)
M263	1	NT7313/XB-AAG Mexican Govt

M264	1	NT7314/XB-AGC Mexican Govt	
M265	1	NT7397/Mexican Govt	
M266	1	NC7422 R L Nafziger	
M267	1	NC7468 Fred Hosiery Mills, Memphis, Tennessee	
M268	1	NT7469/XB-AGD Mexican Govt	
M269	1	NT7470/ Mexican Govt	
M270	1	NC7472International Air Transport, Houston, Texas	
M271	1	NT7473/XB-AAH Mexican Govt	
M272	1	NC7474 Sidles Airways, Lincoln, Nebraska	
M273	1	NC7545 Port Angeles Air Transport, Washington	
M300	1DA	NC5900 J E Mabee, Tulsa, Oklahoma	
M301	1DB	NC6580 Milo R Hilton, Des Moines, Iowa	
M302	1DA	NC6762 Dept of Agriculture, Alabama, to CF-AUH	
M303	1DX	NC9600 Thompson Aero	
M304	1DA	NC9601 Tanner Motor Livery, Los Angeles	
M305	1DA	NC8478 Binghampton Flying Service, NY	
M306	1DA	NX9617 Harry Culver, Culver City, California	
M307	1DC	NC9618 International Air Transport, Brownsville, Texas	
M308	1DD	NC486H Thompson Aero	
M500	1F	NC9691 Tanner Motor, Los Angeles	
M501	1F	NC9693 Col Harry C Fry Jr, Pittsburgh	
M502	1F	NC9692 T T Pendleton, Fort Worth, Texas	
M503	1F	NC9698	
M504	1F	NC8420 Tanner Motor, Los Angeles	
M505	1F	NC8421 Tanner Motor, Los Angeles	
M506	1	NC8424 Bernard Airlines, Youngstown, Ohio	
M507	1F		
M508	1F	NC8420 E A Goff, Battle Creek, Michigan	
M509	1FS	China National Airways	
M510	1F	China National Airways	
M511	1F	China National Airways	
M512	1F	China National Airways	
M513	1F	NC8468 Alaska-Washington Airways	
M514	1F	NC8436, to LN-ABN	
M515	1F	NC8469 Steffens Aircraft, Rutherford, New Jersey	
M516	1F	NC445H	
M517	1F	NC448H McGhee Airways, Alaska	
M518	1F		
M519	1F	NC487H Pilot Radio	
M520	1F	NC404M McGhee Airways, Alaska	
M521	1F	NC413M	
M522	1F	NC910W Western Air Service	
M523	1FS	CF-AMD Yarrow Aircraft	
M524	1F	NC961W	
M525	1F	NC966W	
2000	6A		
2001	6A		
2002	6B		
2003	6B		
2004	6B		
2005	6B	NC463H Trans-american Airlines	
2006	6B		
2007	6B	NC484H Western Air Service	
2008	6B		
2009	6B		
2010	6B		
2011	6B		
2012	6B	to Faucett as pattern for F-19	

Faucett operated OA-BBB to BBG, BBI (msn unkown)

Faucett F-19

1	OA-BBJ
2	OA-BBK
3	OA-BBL
4	OA-BBM
5	OA-BBN
6	OA-BBO
7	OA-BBP, OB-PAA-104
8	OA-BBQ, OB-PAB-105
9	OA-BBR-285
10	OA-BBS
11	OA-BBT, OB-PAC-111
12	OA-BBU
13	
14	OA-BBW, OB-PAD-120
15	OA-BBX
16	OA-BBY
17	
18	OA-BBZ, OB-PAE-132
19	OA-BCA, OB-PAF-133
20	
21	
22	
23	
24	OA-BCB, OB-PAG-139
25	OB-PAH-140, OB-R-140
26	OB-PAI-141, OB-R-141
27	OB-PAJ-143, OB-R-143
28	OB-PAK-144
29	OB-PAO-147, OB-R-147
30	OB-PAR-148

Stinson SM-6000

5004	NC11118	San Francisco Examiner
5005	NC974W	Ludington Line
5006	NC975W	Ludington Line
5007	NC976W	Ludington Line
5008	NC977W	Ludington Line
5009	NC978W	Ludington Line
5010	NC979W	Ludington Line
5011	NC429Y	Ludington Line
5012	NC475Y	Ludington Line
5013	NC497Y	Western Air Service
5014	NC498Y	Western Air Service

Stinson SM-6000B

5015	NC10815	9-seat club model
5016	NC11122	Century Air Lines
5017	NC11124	Century Air Lines
5018	NC11119	Century Air Lines
5019	NC11120	Century Air Lines
5020	NC484Y	Century Air Lines
5021	NC11153	Century Air Lines
5022	NC11155	Century Air Lines
5023	NC11170	Century Air Lines
5024	NC11174	Transamerican Air Lines
5025	NC11175	Transamerican Air Lines
5026	NC11176	Transamerican Air Lines
5027	NC11177	Transamerican Air Lines
5028	NC10804	Century Air Lines
5029	NC10807	Ludington Line
5030	NC10808	Ludington Line
5031	NC10809	Century Air Line
5032	NC10810	Century Pacific Lines
5033	NC10811	Ludington Line
5034	NC10813	Century Pacific Lines
5035	NC10814	Century Pacific Lines
5036	NC10860	8-seat club model
5037	NC10818	Century Air Lines (used by Cord)
5038	NC10822	Pennsylvania Airlines
5039	NC10823	Pennsylvania Airlines
5040	NC11167	Century Air Lines
5041	NC10840	Century Pacific Lines
5042	NC10843	Century Pacific Lines
5043	NC10844	Century Pacific Lines
5044	NC10845	Century Pacific Lines
5045	NC10846	Century Pacific Lines
5046	NC10847	Century Pacific Lines
5047	NC10858	Century Pacific Lines
5048	NC10872	Century Pacific Lines
5049	NC10871	Pennsylvania Airlines
5050	NC10894	Century Air Lines
5051	NC10891	Century Air Lines
5052	NC10892	Century Pacific Lines
5053	NC10893	Century Pacific Lines
5054	NC12168	Century Pacific Lines
5055	NC12130	Pennsylvania Airlines
5056	NC12135	Pennsylvania Airlines

Model U

9000	X432M, NC432M	Lion Airways, Islip, NY
9001	NC12113	American Airways
9002	NC12114	American Airways
9003	NC12115	American Airways
9004	NC12116	American Airways
9005	NC12117	American Airways
9006	NC12118	American Airways
9007	NC12119	American Airways
9008	NC12120	American Airways
9009	NC12121	American Airways
9010	NC12122	American Airways
9011	NC12127	Transamerican Airlines, American Airways
9012	NC12126	Iloilo-Negros Air Express
9013	I-12132	Experimental model, crashed 8/2/33
9014	X12129	U-1, Eastern Air Transport
9015	NC12133	American Airways
9016	NC12136	American Airways
9017	NC12137	American Airways
9018	NC12192	American Airways
9019	NC12193	American Airways
9020	NC12194	American Airways
9021	NC12195	American Airways
9022	Iliolo-Negros Air Express (?)	
9023	NC12196	San Francisco *Examiner*

Model O

10000	X13817
10001	Honduras
10002	Honduras
10003	Honduras
10004	Brazil
10005	Argentina
10006	China
10007	China
10008	China
10009-10011	No confirmation that these allocated numbers were built.

Stinson A

9100	NC14141	American Airlines,
9101	NC14597	Richard J Reynolds
9102	NC14598	Delta Air Lines
9103	NC14599	Delta Air Lines
9104	NC14566	Gannett Newspapers
9105	NC15105	Chinese Govt
9106	NC15106	Central Airlines
9107	NC15107	Central Airlines
9108	NC15108	Central Airlines
9109	NC15109	Central Airlines
9110	NC15110	Central Airlines
9111	NC15134	Delta Air Lines
9112	NC15152	American Airlines
9113	NC15153	American Airlines
9114	NC15154	American Airlines
9115	NC15155	American Airlines
9116	NC15156	American Airlines
9117	NC15157	American Airlines
9118	NC15158	American Airlines
9119	NC15159	American Airlines
9120	NC15160	American Airlines
9121	NC15161	American Airlines
9122	VH-UGG	Airlines of Australia *City of Lismore*
9123	NC15163	American Airlines
9124	NC15164	American Airlines
9125	NC15165	American Airlines
9126	VH-UHH	Airlines of Australia *City of Brisbane*
9127	NC15162	American Airlines
9128	VH-UKK	Airlines of Australia *City of Grafton*
9129	NC16110	American Airlines
9130	VH-UYY	Airlines of Australia *City of Townsville*

* American Airways became American Airlines in 1934.

Selected Stinson Projects

Model B

Twin-engined executive based on Model A with two 245hp Lycoming R-680-B6s. A mock-up was built in 1936 but no production undertaken.

Twin-Stinson

Twin-engined, twin-finned light aircraft design sold to Piper in December 1948. First flown on 2 March, 1952, as the 'Twin Stinson' (N1953A), it was developed into the Piper PA-23 Apache.

Vultee

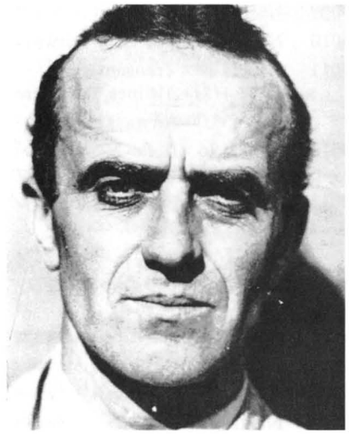
Gerard Freebairn Vultee* was born in New York City in 1900 but grew up in California and attended Polytechnic High School, Los Angeles, then the California Institute of Technology, for three years from 1921. At 'Caltech' Vultee took some of the earliest courses offered in aeronautics and aerodynamics.

In June 1928, John K Northrop resigned as the Lockheed Aircraft Corporation's chief engineer to form his own company. His successor was Vultee, who had been Northrop's assistant and worked under Northrop at Douglas Aircraft, Santa Monica, in 1926, and followed him to Lockheed the next year.

Vultee was responsible for many engineering improvements to the Lockheed Vega transport and designed the low-wing Sirius, in which Charles and Anne Lindbergh flew 'North to the Orient' in 1931. Remembered as a small, shy man with dark, deep-set eyes and a fanatical love of aircraft, Vultee also directed the first application of the NACA cowling to commercial aircraft.

Lockheed was taken-over by the Detroit Aircraft Corporation in 1929, but when the parent company folded in October 1931, Vultee obtained employment supervising engineering courses at the Curtiss-Wright Technical Institute located in the terminal at Glendale, just outside Los Angeles. For a short time, he was also chief engineer for Emsco Aircraft, a division of the E M Smith Co, at its factory at Downey, east of Los Angeles and then in the 'dairy and chicken belt'.

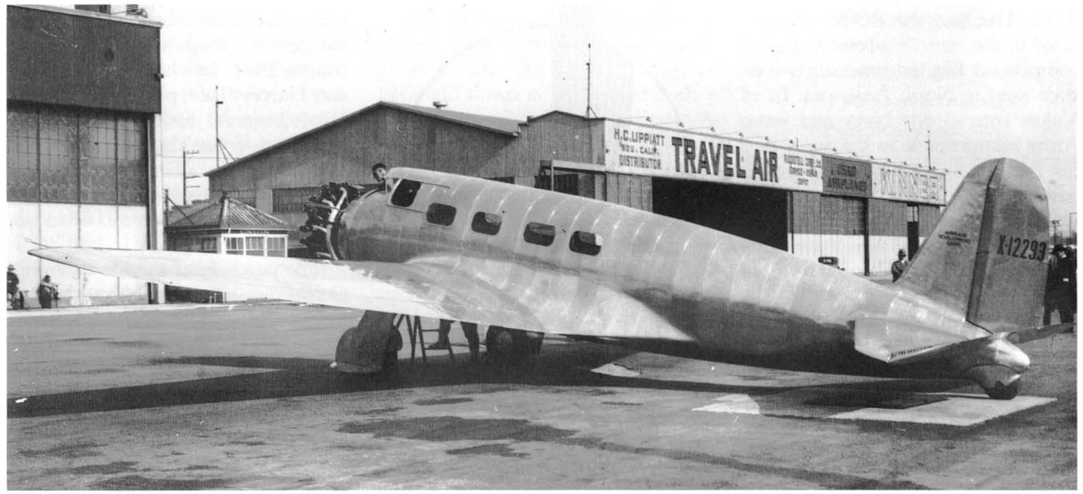
* In contemporary publications, Vultee's given name frequently appeared as Gerald. More commonly, Jerry was also used.

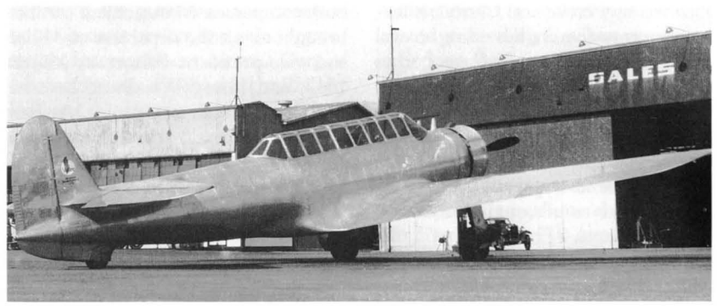


Gerard Freebairn Vultee (San Diego Aerospace Museum)

In September 1931, he left Emsco to search for financial backing for an all-metal single-engined passenger monoplane he had designed with Vance Breese and which had its origins on the drawing boards at Detroit Aircraft. His quest ended with the 'boy wonder of Wall Street', the flamboyant Errett Lobban Cord. A gifted salesman and financier, Cord controlled not only the Auburn Automobile Company, Duesenberg Inc, Stinson Aircraft, Lycoming Motors, and five other motor manufacturing concerns, but also two airlines, Century and Century Pacific. Therefore he saw the design, now upgraded from a six- to an eight-passenger transport, as a high-speed replacement for his fleet of Stinson trimotors. With $50,000 cash, Cord established the Airplane Development Corporation on 26 January, 1932, as a subsidiary of the Cord Corporation. Cord's brother-in-law, Don P Smith, a Los Angeles-based automobile distributor, was appointed president, with Vultee established as chief engineer, assisted by Richard W Palmer. Instead of Breese, a salesman and test pilot, Lee H Smith was appointed sales manager. Initially, Cord gave Vultee space in his private hangar at United Airport, Burbank, but by June, ADC had taken over the former Century Pacific hangar at Grand Central Air Terminal in nearby Glendale.

At the same time, Cord was faced with labour strife at Century because of a move to cut the pilots' already low wages to the bone in an attempt to considerably undercut the prevailing mail rates in the hope of gaining a Post Office subsidy. His strategy failed however, the pilots remained on strike backed by the fledgling Air Line Pilots Association (ALPA), and two fatal accidents tended to confirm the Post Office's view that operating with a minimum overhead would compromise safety. Therefore, Cord sold the assets of Century Air Lines and Century Pacific Lines to his competitor American Airways (later Airlines) in exchange for 140,000 shares of American's parent company, the Aviation Corporation (AVCO). But Cord was not content to let matters rest and quietly began to purchase further AVCO stock. He also acquired controlling interests in two of American's competitors, Martz Air Lines and Thompson Aeronautical Corporation (Transamerican Airlines), and merged these into American Airways. By November 1932, Cord owned 660,000 shares of AVCO or 30 per cent of outstanding stock and there followed a bit-





The prototype V1 at Grand Central Air Terminal, Glendale, California. (Stephen J Hudek collection)

The prototype V11 (msn 28) in front of the Stinson hangar at Grand Central, Glendale. (A R Krieger collection)

ter stock-holder's battle for control of AVCO. This resulted in the resignation of AVCO and American president LaMotte T Cohu and the separation of the airline and the manufacturing concern.

With Cord now victorious after all, a customer – in the form of American – was still available for the Vultee V1 which was first flown on 19 February, 1933. Eventually, twenty-seven examples were built, most going direct to American.

In 1934, Cord went to Europe and the Airplane Development Corp was reorganised as a division of the Aviation Manufacturing Corporation, a subsidiary of AVCO, with Vultee as vice-president and chief engineer. Palmer left to work with Howard Hughes and T C Van Stone became engineering test pilot, a position that had been filled with local pilots previously. However, Stone's tenure was brief as he was killed in the crash of the first V11 on 19 September 1935. The V11 attack-bomber incorporated the wing and tail of the V1 married to a new fuselage and China ordered thirty for one million dollars. Production space was limited at Glendale, therefore in June 1936, Vultee chose to move to the familiar and now empty Emsco plant at Downey. The facility already had a paved runway (but no control tower) and was renamed Vultee Field. In November 1937, came a change of status to the Vultee Aircraft Division of the Aviation Manufacturing Corp. Vultee travelled to China to oversee local assembly of the V11 and additional orders were received from Turkey and Brazil as well as a licence-production contract from the Soviet Union.

Although the new aircraft manufacturer was doing well, a $750,000 profit was recorded for the first six months of 1938, Vultee's designs had been ignored by the Air Corps. Therefore, in January 1938 Vultee left for the East Coast on a sales trip to try and sell the V11-GB, accompanied by his wife, Sylvia Parker Vultee. Returning at the controls of his Stinson Reliant, Vultee took off from Winslow, Arizona, on the morning of 29 January. Shortly afterwards, he flew into a snow storm and crashed on the slopes of Mt Wilson near Flagstaff, where a search party found the charred bodies two days later. The couple left a six-month's old son.

Vultee was succeeded as chief engineer by his assistant, Richard Palmer, now returned from the Hughes H-1B racer project. Former Stinson engineer Charles R Irvine also joined Vultee as project engineer. A syndicate consisting of Victor Emanuel, banking house Schroder Rockefeller, Henry Lockhart, and Tom Girdler (of Republic Steel) had acquired Cord's stock in late 1937 for $2,632,000 and brought in as vice-president Richard W Millar. A Californian investment banker, previously with Universal Studios, and private pilot, Millar had been on the executive committee of Douglas. Vultee lost $60,000 on a contract for seven YA-19s for the USAAC but the order kept the company afloat.

In 1939, four new aircraft were flown in rapid succession, three trainers and one fighter, all based upon the same fuselage, wings and tail, with relatively minor changes to differentiate

them. The first, the BC-51, was entered in the Army's advanced trainer competition but the production contract went to North American. In all Vultee entered one Navy and seven Army competitions in the space of a few months, increasing its engineering costs to nearly $490,000. But in September, Palmer's design for a basic trainer was accepted and three hundred BT-13s were ordered at a cost of $2,995,000. Vultee had intentionally cut its price to win the contract and lost $1,400,000, but massive additional contracts followed and the BT-13 became the standard US basic trainer and over 11,500 were completed at Downey up to 1944.

The trainers had actually been adapted from a pursuit design and this was built as the Vanguard. Vultee had hired Hugh Fenwick as a foreign salesman and after unsuccessful negotiations with France, Turkey, and Yugoslavia, an order for 144 Vanguards was placed by Sweden in February 1940. After the export licence had been rescinded by the State Department, the aircraft were subsequently delivered as P-66s. More lucrative was an order for 300 Vengeance dive-bombers, placed by the French and taken over by Britain in 1940. This contract led to further substantial production of the Vengeance.

Millar was installed as president when Vultee Aircraft Inc was established on 14 November, 1939, to acquire the assets of the Aviation Manufacturing Corp. Yorkshireman Harry Woodhead, president of Truscon Steel (a Republic subsidary), took over the presidency of AMC in April 1940, and in August became Vultee board chairman. Charles W Perelle, previously a production manager with Boeing, was made general manager at Downey and Don I Carroll, also from Boeing, became production manager. Frank W Davis also joined the company that year as project engineer and later was to rise to president of Convair Aerospace.

The size of the Downey plant in 1938 had only been 133,000sq ft (when the only work was the V11 and the working capital at one point was a deficit of $175,000). By May 1940 (when Roosevelt asked for production of 37,000 aircraft in the next 18 months) the factory had grown to 325,000sq ft and this was almost tripled

Vultee logo adapted circa 1934. (John Wegg collection)

to 870,000sq ft a year later.

The first powered assembly line ever used in an aircraft factory was put into operation at Downey in May 1941. Planned by Perelle and Carroll, it featured twenty-five cradles riding an oval overhead track. Raw fuselage frames carried in the cradles passed through twenty-five assembly stations to receive electrical systems, cockpit canopies and instruments. Forty hours later, the frame was ready for sub assemblies such as tails, engines and wing centre sections. The innovation resulted in a completed fuselage every ninety-six minutes and cut final assembly time on the BT-13 from 7,500 man-hours to 3,500. Costs were similarly reduced and the system, itself adapted from the automobile industry, was adopted by aircraft manufacturing plants nationwide. Vultee also pioneered advanced machine processes such as Minster crank presses that cut time in half for wing ribs (instead of using drop hammers), automatic rivet guns, master milling and drilling machines.

Two orders for Vengeances had been subcontracted to Northrop to speed up deliveries before a new factory was completed adjoining Berry Field, Nashville, Tennessee. Built by AVCO for Stinson Aircraft, which had become a division of Vultee Aircraft Inc in October 1939 through a stock transfer arrangement by their common parent, the 180,000sq ft plant started operations in May 1940. However, to bring the factory on to a war footing, the size was increased to 817,000sq ft by autumn and on 8 August, officially purchased by Vultee. Stinson moved back to its now 158,000sq ft site at Wayne, Michigan. Mass production then started at Nashville with the Vengeance, the first delivered in March 1942. In charge at Nashville was Harvey Tafe, previously 'Dutch' Kindelberger's assistant at North American. Vultee's expansion was over three times that of the industry as a whole. From May 1940, employment shot from 1,900 to over 10,000 in late 1941 at the three plants.

The purchase of the Fleet family's Consolidated stock (440,000 shares, or 34 per cent) by Vultee on 25 November, 1941, engineered by Emanuel, head of AVCO, brought control of Consolidated which resulted in a near merger of the two companies. Tom M Girdler was granted part-time leave from Republic Steel and became board chairman and chief executive officer of both companies. Management conflict brought about the departure of Millar and vice-president Palmer in March 1942, and Harry Woodhead became president of both companies. At San Diego, I M Laddon became executive vice-president and general manager of Consolidated and also a Vultee vice-president. Soon after Pearl Harbor, G M 'Monte' Williams became vice-chairman of the Vultee board. He had been general manager at the Dayton Wright Airplane Co but with automobile manufacturing industries for 20 years. David G Fleet, a Consolidated director and son of the founder, was moved to Downey as executive vice-president in 1942.

By then, the mechanics of the formal merger had been drawn up and in January 1943, the directors agreed to the consummation. Consolidated would be the surviving company with a name change to Consolidated Vultee Aircraft Corporation, internally contracted to Convair in June 1943, a term which gradually came into accepted use. However, the name was not officially registered until 1954, when Convair became a division of General Dynamics. Stockholder meetings approved the transaction on 17 March, 1943, and it became effective the next day. The boards of directors were merged, leading executives resigned, and the executive team continued to be Girdler and Woodhead, with Laddon as executive vice-president.

The Vultee Field Division, as it now became known, was instructed to give priority to Vengeance and BT-13 production and several projects, including the XP-54, were delayed. Employment peaked at 7,748 at Downey in November 1943, and after trainer work stopped in June 1944, the plant turned to manufacturing components for B-24s, B-32s, PB4Y-2s and Lockheed P-38s until closed in September 1945.

At the Nashville Division, employment peaked at 6,500 in December 1943, then declined as Vengeance production ended the following spring. The factory then turned out Lockheed P-38 components until awarded a contract for two thousand P-38Ls, but only 113 (43-50226/50338) were completed between January and June 1945, when further production was cancelled.

On 16 July, 1942, Vultee's directors approved the purchase of an international aircraft broker and sales organisation, Intercontinent Aircraft Corp of Miami Springs. Established in 1940 by William D Pawley and Cdr Bruce Leighton, the former partner had been active with aircraft sales in China. Williams, vice-chairman of the Vultee board, was made president and Don Carroll, formerly vice-president of manufacturing at Downey, became vice-president. Following the creation of Convair, the plant became the Miami Division and Intercontinent manufactured components for B-24s, A-35s, P-38s and Vought F4Us until closed on 31 May, 1945. Vultee also opened up a post-production modification centre at Louisville, Kentucky, in the summer of 1942, specialising in B-24s and A-35s, which had 2,214 employees by March 1944.

Also in 1942, the Navy proposed that Vultee build the TBY Sea Wolf as Chance Vought, the originator, was occupied with fighter production. That December, it was announced that Mack-International Motor Truck Corporation's 'Twelfth Street' plant in Allentown, Pennsylvania, would be taken over for this purpose. The Defense Plant Corp spent an estimated $11 million for machinery, auxiliary buildings and an airfield and in August 1943, Convair started work on eleven hundred TBY-2s. The first was not delivered until 15 months later and cancellations gradually reduced employment from a high of 4,990 in spring 1945. The last of 180 Sea Wolfs was delivered in September.

The Vultee engineering staff continued work with several advanced projects. The XP-81, conceived in 1943 and flown in 1945, used both a propeller-turbine and a turbojet. A study for a three-jet Navy night fighter followed in 1944/45, and by April, work had started on possible supersonic designs. With the input of captured German data, studies led to the XF-92A and a family of delta-winged aircraft built by Convair.

The Vultee Field Division was closed in July 1947 and its experimental aircraft, rocket and missile projects were transferred to San Diego. The plant itself was leased to North American Aviation early in 1948.

Today, the only memorial to Jerry Vultee is the 'V' in Convair and the 'Vultee Arch', a natural stone bridge located in Sterling Canyon, northwest of Sedona, Arizona, close to the site of the designer's fatal crash.

Vultee Model Numbers

Vultee used the numbers with prefixes and suffixes to denote the intended role. For example, AB Attack Bomber, B Bomber, BC Basic Combat, P Pursuit, BT Basic Trainer. Rarely was the V prefix used.

Preliminary designs were indentified by a sequential number prefixed by a letter denoting the type, for example XP1015 (Experimental Interceptor Pursuit) and XC1031 (Experimental Commercial).

Presumably all numbers were allocated but only those positively identified by type of aircraft are listed. Prefixes are given if known to have been generally used by Vultee, otherwise are omitted.

V1	Eight-passenger transport
V11	Attack bomber based on V1
V12	Development of V11 known as AB-2 (Attack Bomber 2)
20	Commercial design with Lycoming O-435A
32	Bomber design
33	Observation bomber, single-engine, mid-wing
35	Pursuit design
37	Transport design
38	Attack bomber design
39	Observation bomber, mid-wing design
40	Pursuit design
41	Two-seat cabin design
42	Pursuit design
43	Radio-controlled target design
44	Pursuit design
45	Pursuit design
46	Pursuit design
47	Attack bomber design
P-48X	Built as Model 61, then revised to P-48X Vanguard
49	Turbosupercharged pursuit design (Wright)
50	Scout-bomber design
BC-51	Became BC-3
52	Observation design, similar to YA-19
54	Valiant trainer, became BT-13
55	Bomber design
56	Pursuit design
57	Torpedo bomber (Navy) design
58	Transport design
61	Original Vanguard, changed to P-48X
AB-69	Similar to V-72
70	Pursuit pusher design/Allison V-1710
V-72	A-31, A-35 Vengeance
74	L-1/O-49 (Stinson)
75	Prototype for L-5 series (Stinson)
76	L-5 Sentinel 'Flying Jeep' (Stinson)
V-77	SR-10J/AT-19 (Stinson)
78	Original XP-54 design
80	Cargo transport design
83	Turbosupercharged V-48 proposal
84	XP-54
85	XA-31A
86	V-72 as single-seat type
88	A-35A Vengeance
89	XA-310 (USAAC)
90	XA-41

Vultee Production Summary

Type	*Number*	*Remarks*
V1	27	(plus one airframe to Soviet Union). Final four aircraft built at Downey, others at Glendale.
V11	113	Vultee-built; two at Glendale, remainder at Downey.
	56?	licence-built in Soviet Union and China
V12	1	Vultee-built
	6 ?	licence-built in China and India. China received 51 parts sets.
BC-51/BC-3	1	
54/51-D	1	
54A	1	prototype
BT-13/15/SNV	11,538	includes one skeleton airframe
61/48-X/48-C	1	
48-C	143	
V-72 Vengeance	601	first two built at Downey, rest at Nashville.
	400	Northrop-built at Hawthorne.
V-88 Vengeance	930	Nashville-built.
84/XP-54	2	
90/XA-41	1	
TOTAL	13,822	which includes an estimated 62 licence-built aircraft.

Vultee also built 113 Lockheed P-38Ls at Nashville in 1945.

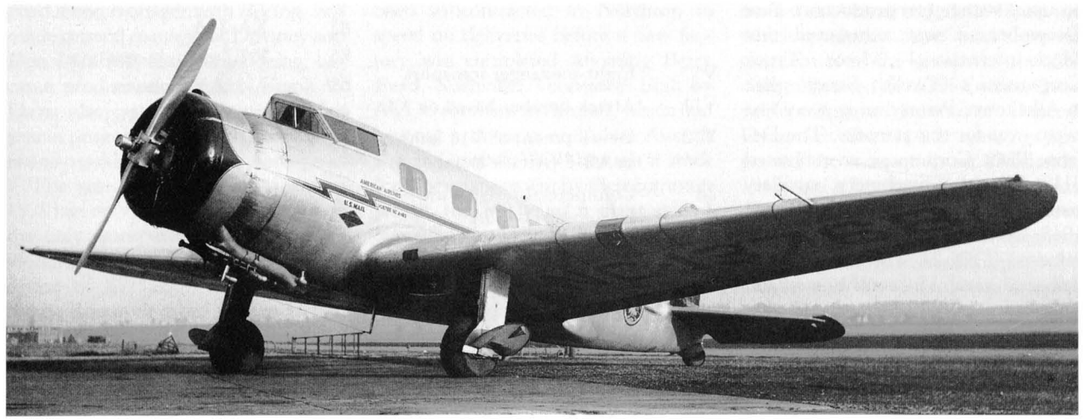
Vultee Aircraft

V1

When, in October, 1931, the Detroit Aircraft Corporation was forced into receivership, Vultee, together with Vance Breese, left to try and find financial backing for a six-passenger transport they had designed that summer. A conventional single-engined all-metal monoplane, the design featured a retractable undercarriage and, incorporating all the latest structural and aerodynamic advances, promised to have the fastest cruising speed of any in its class. Interest in the project was manifested by Errett Lobban Cord, president of the Cord Corporation, who not only controlled the Auburn Motor Company, Stinson Aircraft, and Lycoming Manufacturing, but also two airlines, Century Air Lines based in Chicago and Century Pacific Lines in San Francisco. Seeing the design as a replacement for his fleet of Stinsons, Cord set up Vultee to produce a slightly larger version of his original design in his private hangar at United Airport, Burbank in April 1932. After two months, work was transferred to nearby Grand Central Air Terminal at Glendale and the enterprise established as the Aircraft Development Corporation.

No sooner had work started on the Vultee V1, or Cord-Vultee as it was sometimes referred to, than Cord disposed of his two airlines because of labour troubles. However, through the acquisition of stock he became a director of the Aviation Corporation (AVCO) which controlled American Airways. Thus, there was still a potential customer for the V1 and American placed a tentative order for twenty aircraft at a bargain price of $35,000 each, to be delivered in two batches.

The V1 was a true monocoque design with 'Alclad' sheet metal riveted to an aluminium-alloy oval fuselage frame and a two-spar wing box similarly covered. Only the rudder and elevators were fabric covered. There was accommodation for eight passengers in four rows in the cabin, single seats either side of a 1ft aisle, with a small lavatory aft opposite the starboard-side main entry door and ahead of the baggage and radio compartment. A forward sloping windshield, adopted to prevent glare at night, enclosed the single-pilot cockpit, with half the cockpit space occupied by a 20cu ft mail compartment. The centre section of the wing contained two 103US gal



American Airlines' V1-A NC13768 (msn 6), fleet number A-185 (A R Krieger collection)

V1-A NC4249 (msn 12A) of United Gas, which crashed at Ferris, Texas, on 12 June, 1936. (A R Krieger collection)

capacity fuel tanks and recesses for the electrically-operated retractable main undercarriage. The tailwheel was partially retractable. Then a novel feature, the tailplane was rigidly attached to the fuselage with servo tabs fitted to the control elevators.

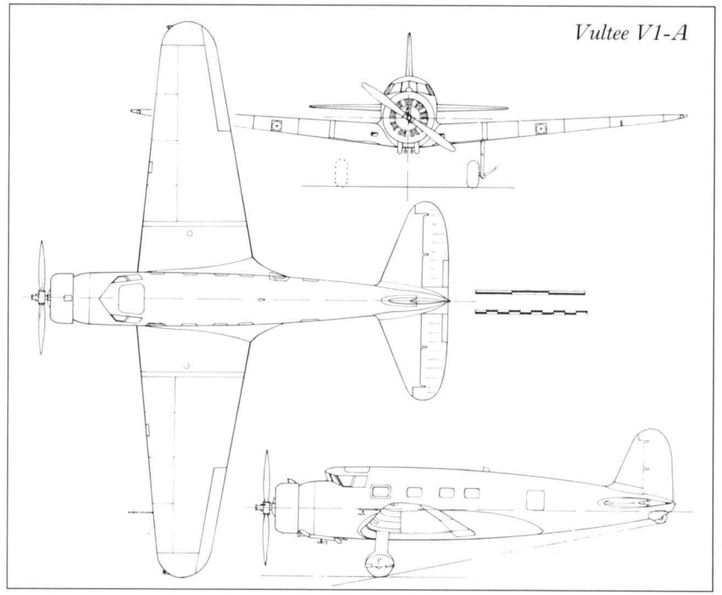
The prototype V1 (X12293), powered by a 650hp Wright Cyclone SR-1820-F2 nine-cylinder radial engine, first flew on 19 February, 1933, from Grand Central, California, in the hands of Marshall 'Babe' Headle, borrowed from Lockheed. Initial tests proved that the V1 could be advertised as the 'world's fastest equipment' and it was handed over to American Airways for evaluation. A two-man crew policy for all passenger-carrying transports was imminent, therefore a position for a co-pilot was added by moving the mail compartment aft of the passenger cabin.

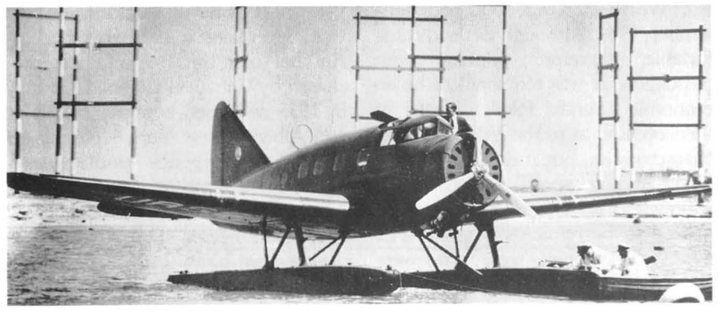
Numerous other changes were made to the airframe, including the raising of the roof line and modifying the shape of the vertical tail. Wing span was increased by two feet, the length from 35ft 6in to 37ft, the wheel track by two feet, the fuselage width by two inches and the height by six inches. The original three-bladed Hamilton Standard propeller was replaced by a two-blade airscrew driven by a higher-compression version of the Wright R-1820-F2 which provided 735hp. Electrically-operated split trailing-edge flaps were installed and in this guise the production version was designated V1-A and work started in February 1934 at Grand Central on the first batch of ten.

Two months later, AVCO lost control of American now re-named with the suffix Airlines, but the order stood. The prototype was sold to American in May, but never received a commercial licence and was restricted to the carriage of mail and express parcels. The first two production aircraft were delivered in July following certification (ATC 545) that month and American Airlines introduced the V1-A on its Fort Worth – Chicago route on 9 September, 1934. Although fast and comfortable, therefore popular with passengers, it was too small to be an economic aircraft. Pilots differed in their opinion as to the Vultee's flying characteristics, but it did have a very high landing speed for the day, although the type's safety record proved to be remarkably good. The new twin-engined transports were almost as fast and American did not confirm the rest of its order thus laying to rest the optimistic plan to build fifty V1-As in 1934.

There was little other airline interest. Bowen Air Lines in Texas acquired two in 1935 – in an arrangement with American – and used them on its Fort Worth – Brownsville and Houston service, advertising a 190mph schedule. Another (msn 16/CF-AWQ) was purchased by Canadian Colonial Airways in 1935 and used between Montreal and Albany, New York – cutting an hour off the flying time – until returned to the USA in 1939.

A directive dated 1 October, 1934, from the Director of Air Commerce, dealt a final blow to the V1-A. Passenger-carrying single-engined aircraft were not to be operated on scheduled US airlines except during daylight hours. The mail services, flown mostly by single-engined types could continue (as long as no passengers were carried) but predictably the major airlines were reluctant to order





V1-A NC13770 was used by Vultee as a demonstrator following its transatlantic flight as Lady Peace. (Stephen J Hudek collection)

The V1-AS flown from California to Moscow in 1936. (Stephen J Hudek collection)

any more single-engined types and gradually began to phase out the ones that were already in service. American lost one aircraft (msn 5/NC13767) and pilot Ted Kincannon in an accident at Little Elm, Texas, on 29 January, 1936, and the remaining fleet of ten V1-As (including the original uncertificated V1) was stored and put up for sale. All were eventually brokered to an agent of the Spanish Republic in late 1936.

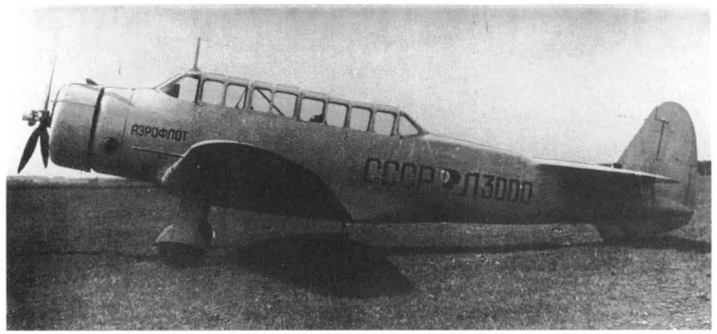
In order to provide another market for the V1-A, deluxe executive versions were offered from the outset which proved somewhat popular. Featuring plush interiors and secretarial facilities, these V1-ADs could be fitted with the 775hp SR-1820-F52 or 850hp SR-1820-G2 resulting in only a slight increase in maximum speed but better all-round performance. Extra fuel tanks could also be installed. The sole V1-AD Special (msn 25) had an 850hp SR-1820-G5 which gave it a maximum speed of 266mph and was delivered to newspaper magnate William Randolph Hearst. Other V1-ADs were delivered to Superior Oil, Houston; Dr Carl P Jones (Grass Valley Mining), California; Lang Transportation in Los Angeles; Crusader Oil; and United Gas. The last named corporation, also Houston-based, requested a change of msn from 13 to 12A but the V1-A was fated anyway, and crashed at Ferris, Texas, on 12 June, 1936.

One (msn 22/NC14256) was delivered to Cord in September 1935, but was re-registered to F J Quinn of Westport, Connecticut, four months later and to B E Smith of Bedford, New York, in July 1936. These names were used by an international business group that obtained oil concessions in Ethiopia. The V1-A was shipped to England and used by British entrepreneur Francis Rickett in Europe, Africa, and the Middle East during his business dealings. In November 1936, Rickett quietly sold the aircraft to Spanish Republican agents.

The V1's particularly high cruising speed made it an attractive mount for record attempts. A new US transcontinental record for passenger-carrying transports was set by James H (Jimmy) Doolittle who, with his wife Josephine and Shell Petroleum Corporation executive Robert Adamson, flew from Burbank to Floyd Bennett Field, New York, on 14/15 January, 1935, in one minute under twelve hours with NR13770 (msn 8). The stretch from Colorado to Virginia was flown entirely on instruments.

A month later, on 21 February, Leland S. Andrews of American Airlines (Doolittle's brother-in-law) with co-pilot Henry Meyers and radio operator G D Rayburn, bettered the time by 25 minutes even with a stop in Washington, DC, to deliver some orchids to Mrs Roosevelt. On 6 March, Andrews flew a V1-A from Los Angeles to Mexico City (1,670 miles) in 8hr 6min at an average speed of 192.8mph – a record that stood until the 1950s. With him were Los Angeles Police Chief James Davies and four other passengers including Vultee and his bride of two months, Sylvia Parker Vultee. The engineer had yet to obtain his pilot's licence.

The Crusader Oil's V1-AD (msn 21/NC14255) – which was actually registered to Richardson and Watts, an investment company – participated in the 1936 Bendix Race from New York to Los Angeles. Flown by William Gulick and William Warner with a navigator and mechanic, it was placed third.



Aeroflot PS-43 SSSR-L3000 (alias BSh-1/V11-GB).
(Robert J Ruffle collection)

But the most notable flight by a V1-A was the first round-trip Atlantic crossing by aeroplane. Acquired by entertainer Harry Richman, msn 8/NR13770 was named *Lady Peace* and modified for extended over-water flight, including extra tanks to give a capacity of 1,006US gal and the novel addition of 40,000 ping-pong balls in the wings to aid buoyancy in the event of misfortune. This was possible because the entire wing was accessible by removing the leading edge sections. Flown by Eastern Air Lines' veteran pilot Henry T 'Dick' Merrill, it left New York's Floyd Bennett Field on 2 September, 1936, and landed near Llandudno in Wales after a record crossing of 18hr 38 min. The return flight from Southport Sands was at least a technical success in that they crossed on 14 September, but they were forced down in Newfoundland, eventually reaching New York a week later.

Of the twenty-seven aircraft built, no less than sixteen V1-As were purchased by agents of the Spanish Republic although four of these were actually captured by Franco's forces en route and therefore saw service with the Nationalists. The surviving American Airlines' fleet made up ten of the twelve Republican V1-As, the others (msn 12 and msn 22) were both executive models, the former purchased via Mexico. One or possibly two aircraft were destroyed by sabotage in France and never reached Spain, one was kept as a VIP transport (probably msn 29), and the prototype was used as a trainer.

At least five, however, were used as attack bombers with eight 75kg bombs stored vertically in place of the passenger seats and a single machine-gun mounted in a dorsal position behind the cabin. The V1-As were flown from Valdepenas, Ciudad Real, and also from El Carmoli, Murcia, for photographic reconnaissance and coastal patrol. Three of the aircraft literally missed the boat for Spain and ended up in China. Four of the V1s survived the war including msn 8 *Capitan Haya* (the former *Lady Peace*). The latter survived until 1953 when it was sold for scrap.

The final four aircraft were completed at Downey following the move of the Vultee Division of the Aviation Manufacturing Corp in 1936. The last V1-A, designated V1-AS, was built for the Soviet Government for a flight from the US West Coast to Moscow via Alaska and Siberia to evaluate a possible air service. Registered as URSS-N208, it had Edo floats (these were exchanged for wheels in Siberia), a cold weather cowling, cabin fuel tanks and an enlarged fin and rudder. During summer 1936, it was flown the 10,000 miles from Santa Monica to Moscow via Alaska and Siberia by Sigusmund Levanevskii and Victor Levchenko.

A twin-engined version of the V1 had already passed preliminary engineering stages by December 1934, but production was cancelled.

V1-A

One 735hp Wright Cyclone SR-1820-F2 nine-cylinder air-cooled radial engine (the F2 was rated 650hp in 1932, upgraded to 712hp on 14 November, 1933, and to 735hp on 6 December, 1933)

Span 50ft 0in; length 37ft 0in; height 10ft 2in; wing area 348sq ft.

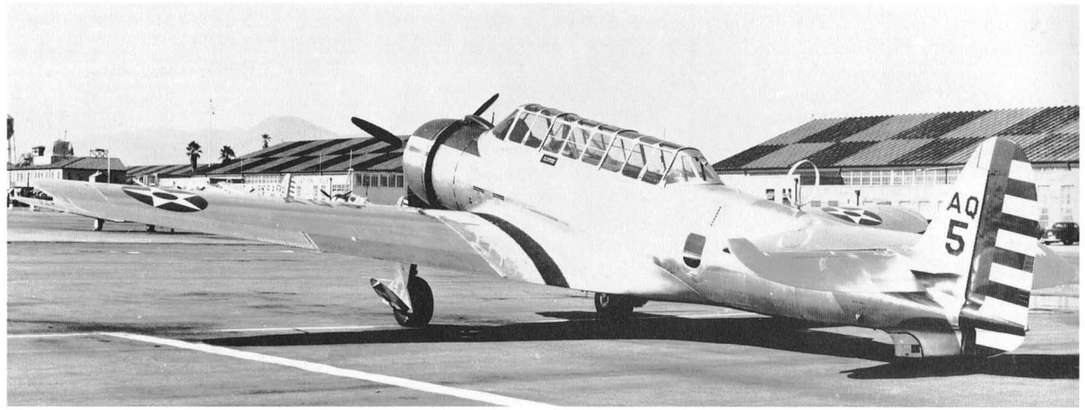
Weight empty 5,332lb; gross weight 8,500lb.

Maximum speed 235mph at 4,000ft; cruising speed 215mph at 10,000ft; initial climb 1,000ft/min.; service ceiling 20,000ft; normal range 1,000 miles.

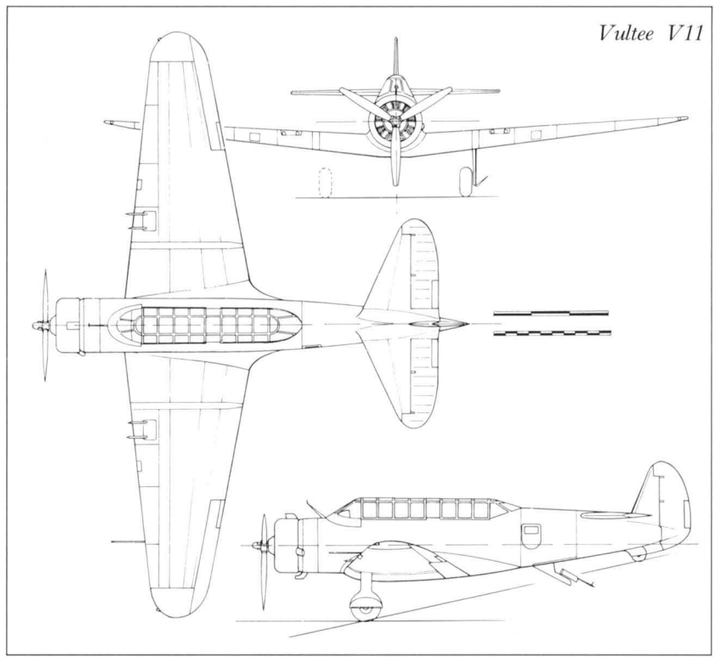
V11 and V12 (YA19)

With the advent of restrictions placed upon single-engined commercial transports in late 1934, Vultee developed an attack bomber based on the design of the V1. The wing, undercarriage and tail surfaces of the V1 were joined to a new fuselage section to produce the V11. Powered by a 750hp Wright Cyclone SR-1820-F53 driving a two-blade controllable-pitch Hamilton Standard propeller, the V11 prototype featured two seats in tandem under a four-section canopy over both cockpits. Provision was made for an aft-firing 0.30in Browning machine-gun and one each in either wing, sighted by the pilot in a pylon-mounted telescopic sight, and up to a 1,100lb internal and external bomb load.

First flown on 17 September, 1935, the first V11 (msn 28/X14999) crashed on take-off for its second flight at Mines Field, Los Angeles, the next day, killing pilot T C Van Stone and project engineer Dugald L Blue. However, a second prototype (NR14980/msn 29) was ready by 9 October. Designated V11-A, it differed by having a three-blade constant-speed propeller and a ring and bead sight. Interest had already been shown by the Chinese Nationalist Government and an order for thirty was placed. The first (msn 30) was completed in December 1936 with a -F53 engine. The rest (msn 36/64) were shipped between July 1937 and April 1938, all without engines and the later batches as sub-assemblies and parts which were assembled at Shanghai and Hangkow. The 850hp R-1820-G2 engines were acquired separately and this powerplant resulted in the designation V11-G. In service at Hangkow with the 14th Squadron, an inter-



One of seven V11-GBs ordered as YA-19s, at March Field, California. (US Air Force)



national unit of American and French pilots and Chinese gunners, they saw limited action against Japanese forces in 1938.

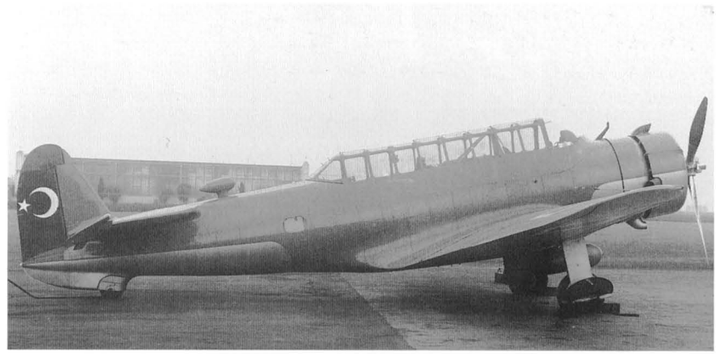
The V11-GB attack-bomber had a third crew member in the lower aft fuselage, who acted as a bomb-aimer/ camera operator and, in a prone rearward-facing position, as a second gunner with a retractable 0.30in gun. Four more 0.30in guns were wing-mounted. Four were acquired by the Soviet Union along with a licence to manufacture the type. The first (msn 32/ NR17328) was flown on 31 January, 1937, followed by msn 33 (NR17329) on 26 February, both with -G2 engines. The other two (msn 34 and 36) were delivered engineless and the first was dismantled for parts. At least thirty-one were built (some reports suggest thirty-five) as the BSh-1 at the Moscow Menzhinskii factory up to December 1938 with a 920hp M-62 (licence-built Cyclone). With armour plate the *Bronirovanny Shturmovik -1* (armoured attacker 1) had a reduced performance and was rejected by the VVS. Consequently, most aircraft were turned over to Aeroflot in 1939 with the designation PS-43 and used on mail flights from Moscow to Kiev and Tashkent. After 1941, they returned to the VVS for communications duties and a few survived until after the war.

Vultee completed a V11-GB as a European demonstrator (msn 31/ NR17327) on 20 January, 1937, but the proposed trip to Europe was cancelled. Instead, the aircraft was used for experimental flying for three months in connection with an order for forty V11-GBTs (msn 65-104) from Turkey. They were delivered between September 1937 and April 1938 to the 2nd Regiment at Diyarbakir and it appears that the demonstrator aircraft went to Turkey as well. These were followed by twenty-six V11-GB2s for Brazil (msn 105-130) completed between June 1938 and March 1939. The last was fitted with Edo floats and a modified tail as a V11-GB2F by Vultee and demonstrated to the Brazilian Navy. Suffering from corrosion, it was not accepted by the Army. Two other V11-GBs (msn 31 and 33) were also converted to seaplane configuration as V11-GBS (or -GBF) and a similar V11-TS, capable of carrying a 1,600lb torpedo, was proposed to the Netherlands but not built.

On 24 June, 1938, the US Air Corps ordered seven V11-GBs (38-549/555 msn 132/138) as service test aircraft, a result of Vultee's fateful sales trip east six months earlier. Designated YA-19s with a 1,200hp Pratt & Whitney Twin Wasp R-1830-17 and an armament of six 0.30in guns and a 1,080lb bomb load, the first was flown on 27 January, 1939. Five more were delivered in June and July but the last became the XA-19A with a liquid-cooled twelve-cylinder 1,200hp Lycoming O-1230-1 and enlarged vertical fin to compensate, and first flew on 22 May, 1940. Subsequently it became the XA-19C with a Pratt & Whitney R-1830-51. The second YA-19, redesignated XA-19B, was assigned to Pratt & Whitney and received a 1,800hp R-2800-1 at Rent-schler Field. The other five YA-19s served at March Field, California, then with military attachés in countries bordering the Panama Canal Zone.

On 13 September, 1938, Vultee flew an updated model designated AB-2 (X18985 msn 131). Incorporating the Twin Wasp R-1830-S1C3, it featured a streamlined canopy faired into a deeper rear fuselage, a fully – instead of partially – retractable tailwheel, and two 0.50in and two 0.30in guns. China ordered twenty-six aircraft, designated V12-C, with the 1,100hp Wright Cyclone GR-1820-G205B. The prototype (NX28367 msn 143) flew in February 1940 but was damaged in a taxiing accident on 25 January, 1941, and was still stored at Nashville in August 1944. The other twenty-five were shipped as parts for assembly by the Central Aircraft Manufacturing Company at Loiwing. China also ordered fifty-two V12-Ds with the 1,600hp Wright GR-2600-A5B and these had a similar canopy and fuselage shape to the V11, but a taller fin and rudder. One pattern aircraft (msn 144) was shipped to China in 1940 but few aircraft had been completed locally before the factory was bombed by the Japanese on 26 October. Production was resumed on behalf of the Chinese by Hindustan Aircraft Ltd at Bangalore in India, but only three were completed. One or two were operated under the auspices of Pakistani Aviation in an agreement arranged by William M Pawley of Intercontinent Aircraft at Miami.

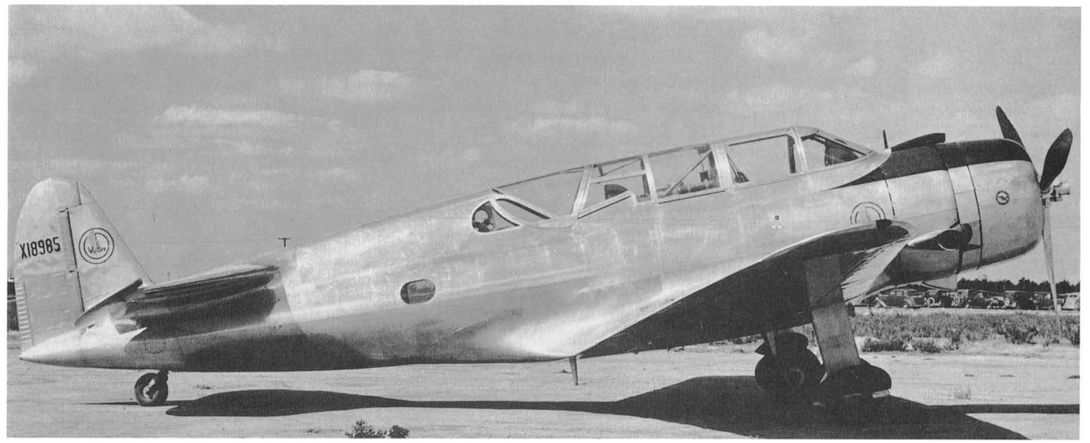
The final development of the series was the V11-T, converted from the V11-A for use as an engine test-bed by Pratt & Whitney at Hartford, Connecticut. First flown on 21 January, 1940 (as NX14980), the two-seat cockpit was situated behind the wing and a



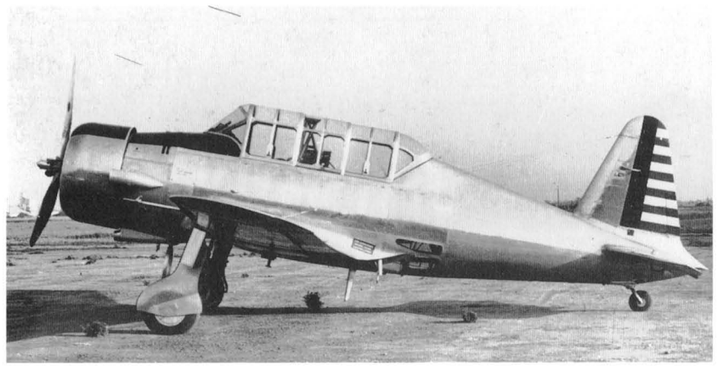
One of the Turkish V11-GBTs at Downey, California. (Stephen J Hudek Collection)

The Edo float-equipped V11-GB2F for Brazil. (Stephen J Hudek collection)

The AB-2 (Attack Bomber 2) was ordered by China as the V12. (Convair)



Second prototype V11 was eventually converted as an engine test-bed for Pratt & Whitney as the V11-T. (Stephen J Hudek collection)



The BC-51 after upgrading to USAAC BC-3 standard.
(R T Martin collection)

larger rudder and non-retractable undercarriage installed. The forward fuselage was removable to allow heavier and larger engines to be installed. The V11-T was destroyed in an accident on 20 March, 1945. Pratt & Whitney also obtained the AB-2 for engine testing in 1940 and it was used up to 1948, but scrapped two years later.

V11-GB

One 850hp Wright Cyclone GR-1820-G2 nine-cylinder air-cooled radial engine.

Accommodation: Three crew

Armament: Four 0.30in machine-guns in wings, two 0.30in guns in rear cockpit (one in ventral position) and up to thirty-six 30lb bombs internally and a 1,100lb external load.

Span 50ft 0in; length 37ft 5½ in; height 10ft 0in; wing area 384sq ft.

Weight empty 6415lb; gross weight 9,863lb (attack); 11,799lb (bomber).

Maximum speed 238mph at 18,000ft; cruising speed 214mph at 15,000ft; climb 1,400ft/min. at sea level; service ceiling 28,000ft; maximum range 2,380 miles (494US gal fuel capacity).

Model 51 and 54 Valiant (BC-3, BT-13/15, SNV)

In late 1938, Richard Palmer was working on a speculative pursuit design when the Army announced a design competition for an advanced trainer. A substantial order was likely, based upon a prototype demonstration. Therefore, Palmer and his engineering team under the leadership of Walt Hite quickly adapted the existing pursuit design and just 88 days after Palmer had drawn up the first rough sketch, the unregistered prototype (msn 139), designated BC-51 (Basic Combat), made its initial flight on 24 March, 1939, in the hands of Eddie Allen.

Powered by a 600hp Pratt & Whitney Wasp R-1340-S3H1G, the all-metal semi-monocoque BC-51 had a wing section of NACA Symmetrical aerofoil incorporating integral tanks, hydraulically-operated flaps and a retractable undercarriage. All movable control surfaces were fabric covered.

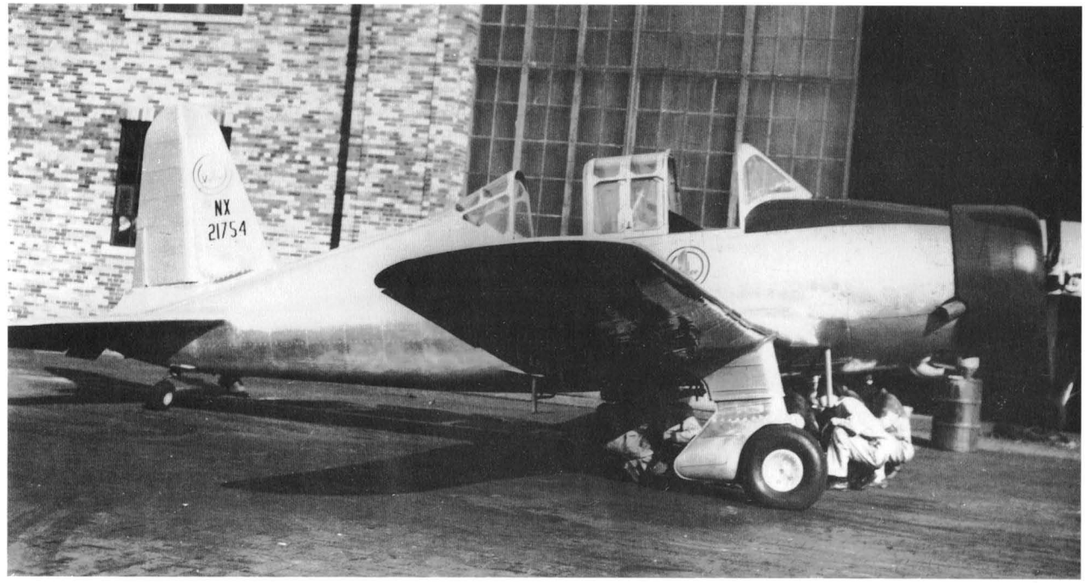
In May 1939, the BC-51 was entered in the USAAC competition at Dayton but the production contract went to North American for its BC-2. However, the BC-51 was purchased as the BC-3 (39-720) by the USAAC on 30 June, and the BC-51 returned to Downey and was upgraded to Air Corps standards. Reflown on 15 March, 1940, no production contract followed.

Based on the same airframe, the lower-powered unarmed Model 54 advanced trainer (NX21753 msn 140) followed on 9 June, intended for export under the name Valiant. However, performance was poor and it was upgraded with a R-1340-S1H1G engine almost to BC-51 standard. Re-designated 51-D, it was first flown on 15 November, 1939, but crashed the next day injuring test pilot Gil Clark.

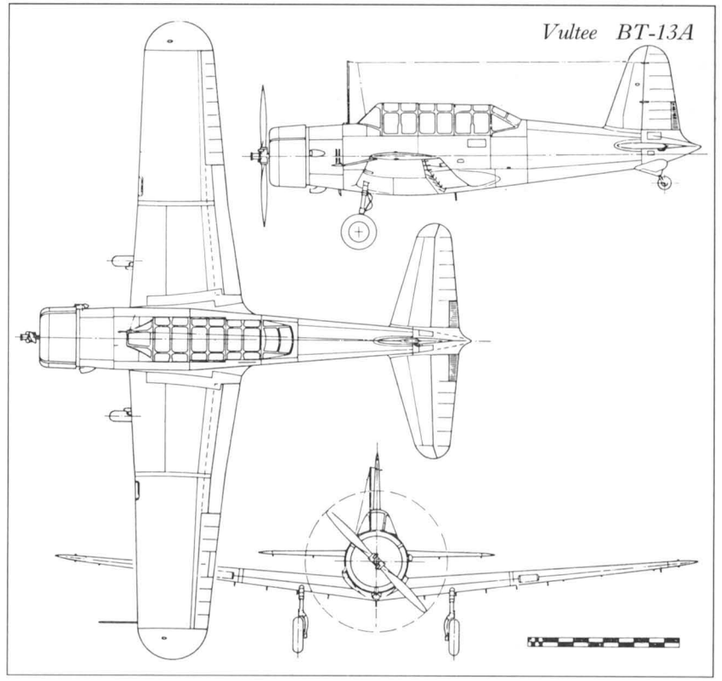
Next in the same series was a non-retractable undercarriage version, the Model 54A Valiant (NX21754 msn 141), powered by a 450hp Pratt & Whitney Wasp Junior R-985-T3B with a two-blade propeller and first flown on 28 July. The following month, the 54A was selected as a new basic trainer, the BT-13, and this was to be produced in greater numbers than any other BT type and trained more US aircrew than any other aircraft during the Second World War.

An initial order for three hundred BT-13s with the 450hp R-985-25 was placed on 16 September, 1939, then the largest USAAC trainer contract placed. One skeleton airframe (msn 200) was completed on 13 January, 1940, and delivered to the USAAC followed by the first complete aircraft (40-810 msn 201) in mid-February, fitted with an R-985-27. Production deliveries (40-811/1109 msn 202/500) started at the end of June, initially to Kelly, and were complete by January, 45 days ahead of schedule.

Volume production continued – the first aircraft built on a mechanised assembly line – with orders for 7,037 BT-13As with the R-985-AN-1 and without the main undercarriage leg fairings, and 1,125 BT-13Bs with a 24-volt electrical system. With these massive orders, Pratt & Whitney could not keep up with engine deliveries and thus another 1,263 aircraft were completed as BT-15s with the 450hp



The Model 54A Valiant (NX21754), which led to the massive contracts for the BT-13 series.
(A R Krieger collection)



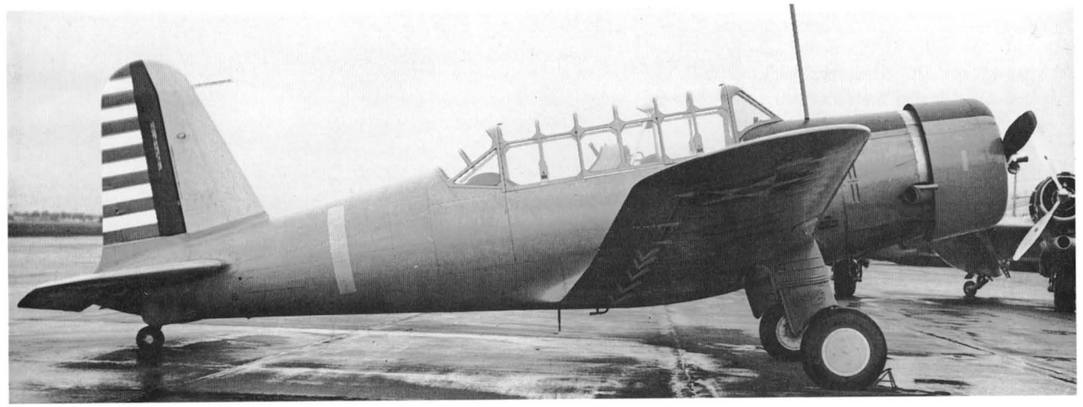
Wright R-975-11.

An order from Peru was received for twelve BT-13As and these were delivered in October 1941. Orders were also received from the Navy for 1,150 SNV-1s and 650 SNV-2s, equivalent to the BT-13A and BT-13B respectively. Two SNV-1s (V222/223) were delivered to the US Coast Guard. By 1942, Downey produced 250 aircraft a month for a total of 11,537 (plus the skeleton airframe) by 1944. The sole XBT-16 was a BT-13A rebuilt by Universal Products Corp (formerly Monocoupe Aeroplane and Engineering Corp) at Bristol, Virginia.

In service, the stable BT-13 quickly became known as the 'Vibrator' because of its behaviour when it approached its quite violent stall (75 mph/clean). Unattractive, noisy, unforgiving, but capable of almost any aerobatic manoeuvre in skilled hands, the Vibrator gained an undeserved reputation as a 'widow maker', simply because of its widespread use in a wartime system with a high casualty rate. Despite much mishandling, there is no record of an in-flight structural failure occurring to any aircraft of the series.

The United States supplied a significant number of BT-13/15s from military stocks to Central and South American countries under lend-lease from 1942 as follows: Bolivia (BT-13); Brazil (120 BT-15s, last withdrawn 1959); Chile (approximately forty, withdrawn 1959); Colombia (fourteen BT-15s, withdrawn 1951); Dominican Republic (BT-13); El Salvador (BT-13); Guatemala (five BT-15s); Honduras (twelve BT-13s, the last withdrawn 1967); Mexico (eighteen BT-13s and nineteen BT-15s, in service until 1958); Nicaragua (one only, 42-41898); Paraguay (BT-13); and Venezuela (twenty-three BT-13B/15). Postwar, Argentina received some for the Navy, later Air Force, and Haiti received two in 1946.

Elsewhere, forty to France, used at Meknès, Morocco, with survivors to



A BT-13 in 1940 in standard blue and yellow USAAC training colours. (A R Krieger collection)

Typical of many BT-13 series conversions for agricultural use is this single-seater with hopper located forward of the pilot. (John Wegg)

Cognac until late 1950s, thirty were supplied to China under lend-lease, and small quantities were used by Indonesia (its first aircraft), Israel (101 Squadron, Herzliya), and the Philippines.

The vast majority of US military aircraft were swiftly disposed of as surplus after VJ-Day, because of a preference for the more advanced North American AT-6. Large quantities were purchased by agricultural concerns for engines and spare parts which were donated to Stearman biplanes but many were used for crop-spraying, often with extensive modifications. One example was N75133, rebuilt by Ken Tyler of Long Island as a single-seater with a 125US gal capacity spray tank in the rear cockpit area.

Nick Moller of California modified one in 1963 with a T-6 engine and a 300US gal tank for fire-fighting but this was not used operationally. Another (NC56897) was converted with a three-seat rear cockpit and more radically, three BT-13s were converted to six-seaters in a '2+2+2' configuration with a widened and streamlined fuselage and one of these is still flying. Another nine BT-13s were modified by Steward-Davis at Long Beach in 1968 with the R-1340 engine and a 26in fuselage plug to pass for Aichi 99 Vals for the film *Tora, Tora, Tora.* In Alabama, one BT-13 (N65858) was tested as a biplane cargo transport with the second, shorter wing mounted over the canopy.

A single-seat sprayer conversion of the BT-13 series made by Marsh Aviation, Mesa, Arizona. (John Wegg)

Today, there are still one hundred and sixty BT-13/15s registered in the USA, but this number includes many hulks. About half that total are flyable and of those only thirty or so are close to their original configuration.

BT-13A

One 450hp Pratt & Whitney R-985-25 Wasp Junior nine-cylinder air-cooled radial engine.

Span 42ft 2in; length 28ft 10in; height 9ft 1in; wing area 238sq ft.

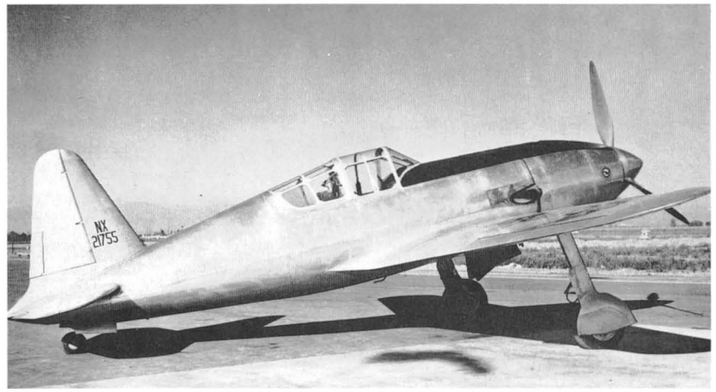
Weight empty 3,375lb; gross weight 4,496lb.

Maximum speed 166mph at 1,400ft; maximum cruise 140mph at 5,000ft; climb 1,050ft/min at sea level; 10,000ft/9.2 min; service ceiling 16,500ft; range 516 miles (120US gal fuel capacity).

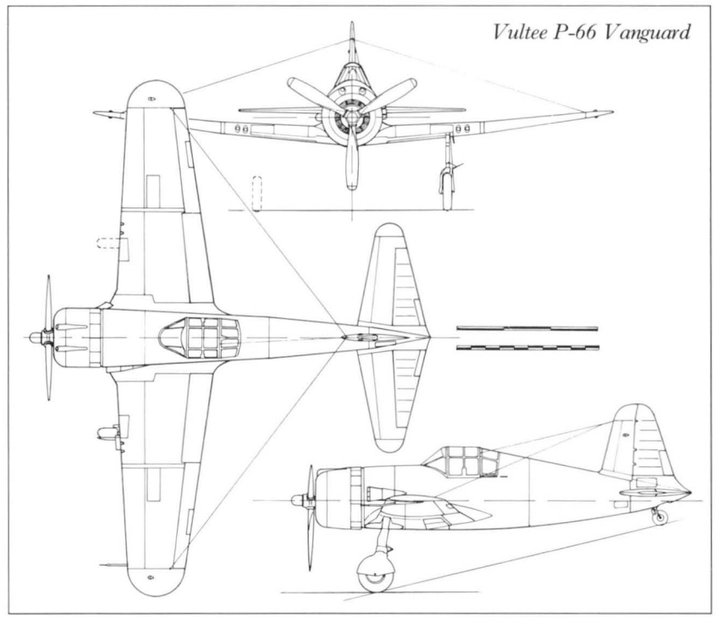
Model 48 and 61 Vanguard (P-66)

After the three trainers had been produced in 1939, Vultee reverted to Palmer's original pursuit design, the Model 48 Vanguard, patterned after the H-1B racer he had designed for Howard Hughes. With a similar fuselage and the same tail, wing centre section and retractable undercarriage (including the tailwheel) as the BC-51 and Model 54 trainers, the Vanguard's detachable outer wing panels shortened its wing span by 6ft. An armament of ten 0.30in machine-guns was originally proposed, including two firing rearwards aimed by mirrors, but this latter idea was abandoned during development and a conventional layout adopted, two 0.30in guns in the cowling and four wing-mounted 0.50in guns.

During the design stage, Pratt & Whitney offered an extended-shaft version of its Twin Wasp R-1830 and the model number of the first Vanguard was changed to 61. The 1,050hp R-1830-S2C6-G engine was almost completely enclosed in a low-drag cowling with a retractable air intake positioned beneath, directly behind the massive spinner. A company demonstrator (NX21755 msn 142) was first flown on 8 September, 1939, by Vance Breese. But problems surfaced immediately with the cooling duct which had to remain in the open position, and a further air intake was added above the cowling.



The Model 61 Vanguard NX21755 in its original configuration. (R T Martin collection)



However, continuing cooling problems led to the adopting of a conventional R-1830-S1C3-G and cowling. In this form the prototype was redesignated Model 48X and was flown in this configuration for the first time on 11 February, 1940. Because of instability, the rudder and tailplane areas were increased and the wing given compound instead of straight dihedral, with a break at the mid-section.

On 9 May, following a photographic flight, the P-48X (as it was commonly referred to) collided with Paul Mantz's Lockheed Sirius during the descent into Vultee Field (Downey). The fighter's propeller struck the transport's fuselage, killing the pilot, cameraman, and a Vultee writer. One undercarriage leg of the P-48X was severed and as Breese could not be warned from the ground because Vultee Field then lacked a tower, he crashed on landing.

However, five days before the P-48X had flown, Sweden signed a $11.5 million contract for 144 aircraft

P-66s for China lined up at Karachi. The airship hanger is at top right. (R T Martin collection)

with the -S3C4-G engine which offered more power at altitude. This version was designated Model 48-C (Flygvapen J10). Thus, the P-48X was rebuilt to 48-C standard and, re-registered NX19999 (with msn 501), was first flown on 6 September, 1940. The second 48-C (NX28300 msn 502) was rolled out on 1 November. Both these aircraft were fitted with -S2C4-G engines.

Meanwhile, fearing losses to Axis forces, the US State Department had declared an embargo on all exports of war material to Sweden in September. Therefore, three months later, following an inspection by Squadron Leader James Adams, 100 aircraft were assigned to Britain (which had earlier rejected the design) under lend-lease as Vanguard Is (BW208/ 307) for use as advanced trainers in Canada. On 19 May, 1941, Britain agreed to release the Vanguards for supply to China for Chiang Kai-Shek's beleaguered Nationalist forces and the 144 aircraft (including msn 501/502) were given the USAAF designation P-66 and serials 42-6832/6975 and delivered between 24 October, 1941, and 20 April, 1942. However, the first three aircraft were painted in RAF markings and one carried Swedish roundels for photos.

Upon completion, most P-66s were either stored at Downey or at March Field, California, but in December 1941 following the Japanese attack on Pearl Harbor, between forty and fifty aircraft intended for China were turned over to the 14th Pursuit Group for the defence of southern California at March Field, Reeves Field (on Terminal Island), and Long Beach. Early in 1942, they were moved north to Hamilton AFB, then to NAS Oakland to defend the Golden Gate and one (42-6878) was lost in San Francisco Bay because of engine failure.

Flying performance of the P-66 was exceptional and it was described as 'fantastic' for aerobatics. Test pilot Gil Clark rated it the best aircraft he ever flew, far superior to the Curtiss P-36. But Service pilots reported that the cockpit layout was very poor and for a fighter, the P-66 was not robust.

The first shipment for China finally left Long Beach in February 1942, followed by forty more two months later. Another ninety-one were flown to Roosevelt Field, New York, but fifteen were destroyed in accidents during testing or during delivery, many suffering ground loops. The remaining seventy-six were shipped between April and August, the first batch of thirty-four taking two months to reach India. At Karachi, the P-66s were reassembled, tested – initially by Vultee pilot Elwyn Gibbon – then handed over to the 35th Pursuit Group or Chinese crews and ferried to Cheng-tu in USAAF markings.

Many Chinese pilots, having trained on nosewheel Bell P-39s, were unqualified for the P-66 and several were lost during tests or en route; others remained unairworthy at Karachi. One was rebuilt from several wrecked aircraft and flown with an R-1830-92 engine. Official records show that 104 aircraft were received by the Chinese Air Force (assigned serials in the P-13002 to P-26886 range) although the actual number that reached China was probably less. About twelve were on strength with the 76th Fighter Squadron, 23rd Fighter Group, at Kunming but saw little use. Others saw action with two Chinese squadrons at An-Su from August 1943. Many were lost on the ground during Japanese attacks and because the overall appearance of the P-66 was similar to the Japanese Oscar or Tojo, at least two were shot down in error by their own side. Still others were placed in caves for storage at Chungking for use in the coming civil war against the communists and many were reported still in crates as late as 1947.

The Model 83 Vanguard was projected with a turbosupercharged R-1830-C4G, NACA cowling and spinner expected to offer a maximum speed of 410mph and a ceiling of 34,000ft but was not built.

P-66

One 1,200hp Pratt & Whitney R-1830-33 (S3C4-G) fourteen-cylinder air-cooled radial engine.

Armament: Two 0.30in machine-guns in cowling and four wing-mounted 0.50in machine-guns.

Span 35ft 10in; length 28ft 5in; height 10ft 0in; wing area 196.7sq ft.

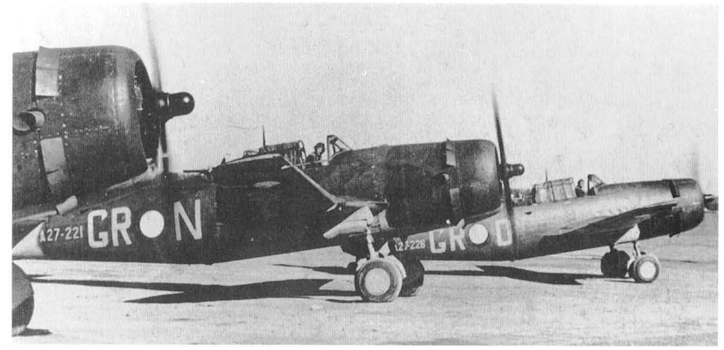
Weight empty 5,237lb; gross weight 7,384lb.

Maximum speed 340mph at 15,100ft; cruising speed 290mph; climb 17,000ft/ 9.2 min; service ceiling 28,200ft; combat range 850 miles.

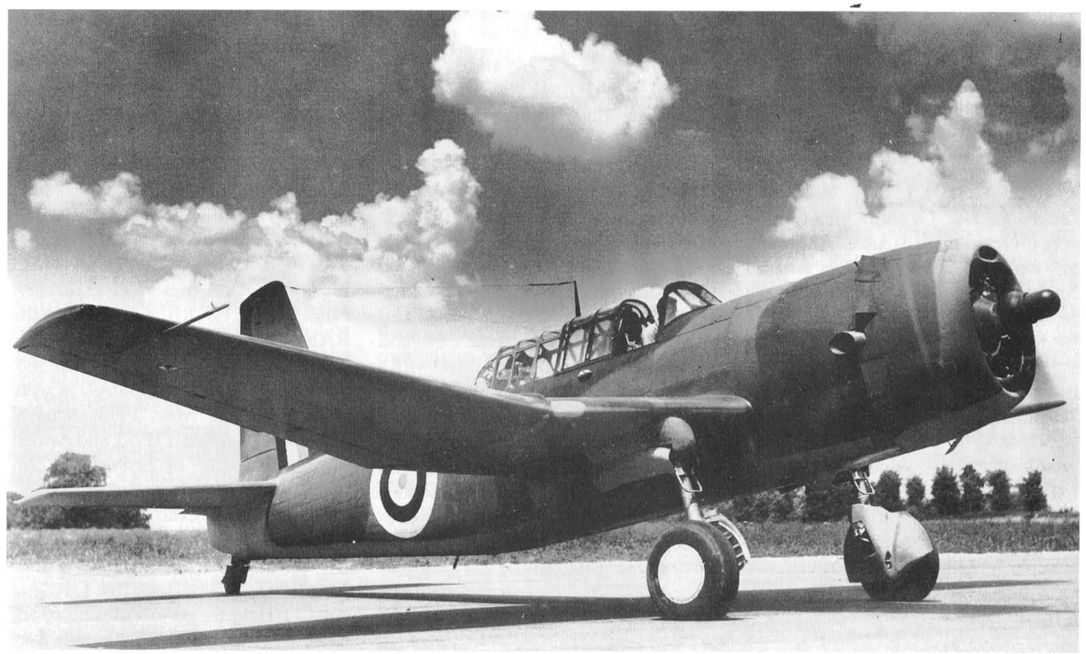
V72 and V88 Vengeance (A-31, A-35)

As a result of the organisational changes within Vultee made in early 1940, Richard Palmer became vice-president for engineering and under his supervision a new design was drawn up to meet a French requirement for a dive-bomber. Deliveries of 300 aircraft were to begin in October 1940 and continue for eleven months. However, the fall of France in June 1940 negated these plans but at the same time the British became interested in such an

RAAF Vengeance IIs (V72). (Geoff Goodall collection)



Nashville-built A-31-VN Vengeance II AF797 for the RAF. (Convair)



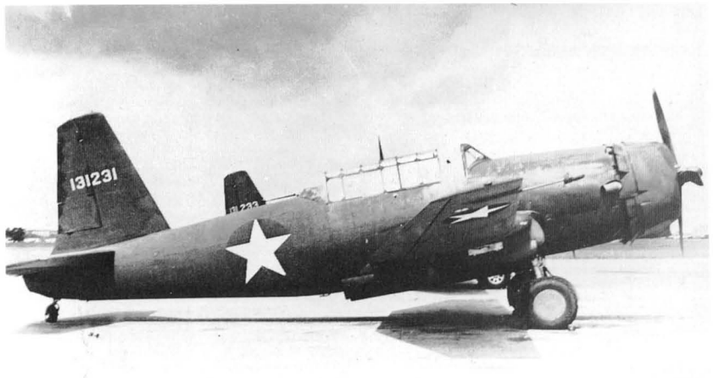
aircraft. As there were no suitable types available from any other source, the V72 was chosen and a contract for 200 Vengeances, as the type was named by Vultee, was placed by the British Purchasing Commission on 3 July, 1940. On 2 December, another 100 were ordered.

A tandem two-seater for a pilot and gunner, the Model 72 was powered by a 1,600hp Wright Cyclone GR-2600-A5B-5 and had a W-shaped wing planform with no incidence. The centre section had a sweptback leading edge and the outer panels, with dihedral, had straight leading edges and forward sweep on the trailing edges. Slotted all-metal dive-brakes were fitted to the undersides of the outer panels and the hydraulically-retractable main undercarriage retracted backwards through 90 degrees to lie covered in fairings under the centre section. The control surfaces were fabric covered. Armament consisted of six 0.30in guns, two flexible and four fixed in the wings and two 500lb bombs in the fuselage bomb bay. Two more 250lb bombs could be carried as overload and this hefty aircraft was stressed to plus 12g.

The first prototype (AF745 msn 4101) was completed with twin fins and rudders but following one taxi-ing trial, contract test pilot Vance Breese refused to fly it in this configuration. Thus the first flight from Downey on 30 March, 1941, was made with a single fin and rudder, very similar to that of the Vanguard, which had, in fact,been fitted to the second aircraft (AF746 msn 4102).

Already committed to mass production of the BT-13 at Downey, Vultee subcontracted 200 of the order to Northrop Aircraft at nearby Hawthorne on 25 February, 1941. Orders for another 400 and 200 Vengeances, to be produced by Vultee and Northrop respectively, were placed by the RAF in April and June. These new orders were placed on lend-lease on 28 June, and the Vengeance was given the type designation A-31 for USAAF procurement purposes. In order for Vultee to manufacture the Vengeance in quantity, AVCO had purchased the Stinson plant at Nashville, Tennessee, in August 1940.

Northrop's first batch of 200 (AN838/999, AP100/137) were completed as V72 Vengeance Is and the initial aircraft was first flown on 30 November, 1941, by Moye Stephens.

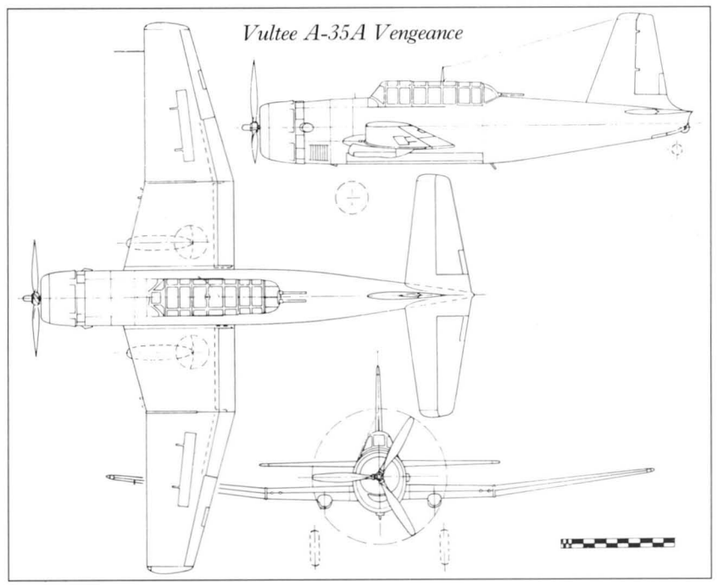


USAAF A-35A-VN (V88) 41-32131. (A R Krieger collection)

Deliveries began the following January. The second 200 (EZ800/ EZ999 ex-41-30848/31047) were A-31-NO Vengeance IAs. Of these, ninety-nine were diverted to the RAAF (A27-1/99) and when the United States entered the war, others were repossessed with the designation RA-31 (for Restricted). Production by Northrop of the V72 ended on 22 August, 1942, and that of the A-31 on 18 May, 1943.

Vultee's initial five hundred aircraft (AF-745/AF944, AN538/837) were completed as Vengeance IIs and the first production machine was first flown in December 1941. One (AN679) that crashed before delivery, was later replaced with an extra aircraft (FP686). However, 243 were retained by the USAAF (designated V-72) and 122 were diverted to the RAAF (A27-200/321) as by the time full-scale production started at the new Nashville factory in March 1942, the dive-bomber concept had become unappealing to the RAF.

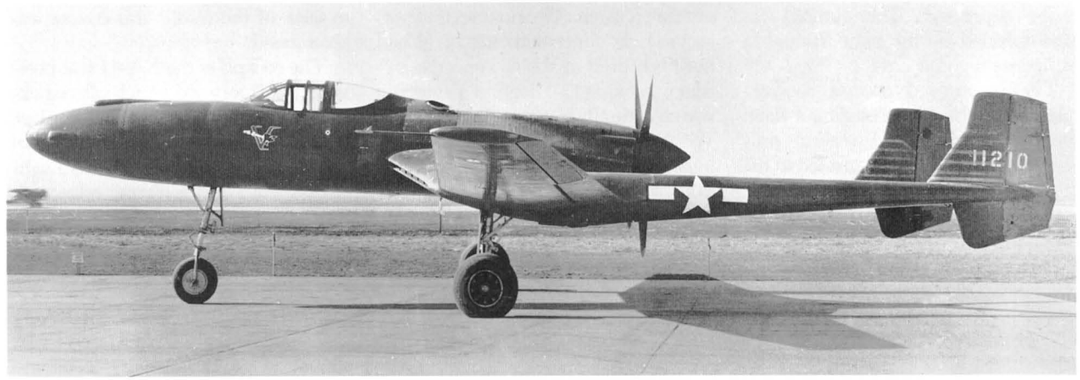
The prototype Vengeance (AF745) was redesignated V85 and accepted in June 1942 as the XA-31A (42-35824) without engine or armament and became the XA-31B when fitted with a 3,000hp Pratt & Whitney Wasp Major XR-4360-1. The XA-31C (msn 4115 AF759) was used as a test-bed for the 2,200hp Wright Cyclone R-3350-18. Five other V72s (AF756/782/845/ 887/904) modified to test R-3350-17s with four-blade propellers for the Boeing B-29 programme were know as YA-31Cs.



A further one hundred A-31C-VN Vengeance IIIs (FB918/FD117 ex-41-31048/31147) were built by Vultee be-fore a change was made to the A-35A (99 built, 41-31148/31246). This model (V88) was a result of recommendations from Army pilots that the Vengeance be brought up to USAAF armament standards with five 0.50in guns and the wing modified with a four degree angle of incidence to improve pilot visibility. The balance of 201 aircraft of the second order (41-31247/31447) were completed as A-35Bs with the 1,700hp R-2600-13 (later -8) engine, six 0.50in wing guns, and racks for ferry tanks or two more 500lb bombs. Further orders for 630 more A-35Bs (42-94149/94548, 42-101236/ 101465) were placed to make a total of 1,931 Vengeances produced up to 6 June, 1944. Another 104 A-35B Vengeance IV-1s (FD118/221) and 458 Vengeance IV-2s with R-2600-8 engines (FD222/417, HB300/ 550, KG810/820) went to the RAF, along with 121 to the RAAF (A27-400/422, -500/549, -560/566, -600/ 640). Another 2,035 A-35s were cancelled on 20 May, 1943. A naval version, designated TBV-1 and named Georgia, capable of carrying a 22in torpedo was not proceeded with.

Some sixty-seven A-35As and A-35Bs were supplied to the Free French Air Force in North Africa from June 1943, mostly used by GB I/62 and GT II/15 for gunnery training, but these were found unreliable and they were returned by the following April. Brazil was supplied with twenty-eight V-72s (AN581/608). One crashed en route and the balance, delivered by 4 February, 1943, were accepted by the 1st Dive-Bombing Squadron at Santa Cruz, near Rio de Janeiro. A second batch consisting of five A-35Bs was received in September 1944 for the 2nd Squadron at São Paulo. However, only limited submarine patrols were flown. In May 1945, the surviving aircraft were renumbered with Brazilian serials (6000/6025, 6056/6060) but many were already grounded with mechanical problems and all were disposed of by May 1948.

Considered unsuitable for action in Europe, most of the RAF Vengeances were sent to the Far East and No.82 Squadron was the first to receive the



type, at Bombay in August 1942, followed by Nos.45, 84, and 110. Two squadrons (Nos.7 and 8) of the Indian Air Force followed suit and the Vengeance saw action in Burma from March 1943 until July 1944. Five RAAF squadrons (Nos.12, 21, 23, 24 and 25) received the Vengeance from May 1942. Operations against Japanese-held islands began five months later and continued until the Vengeance was replaced by B-24s in March 1944. The 228 survivors were all in storage by the end of the war.

Well over three hundred A-35Bs were converted as target tugs without armament (which reduced the overall weight by 2,435lb) and the few that did reach the United Kingdom were mainly employed in this capacity by various non-operational squadrons including Nos.228, 289, and 695, as well as by three Royal Navy squadrons, Nos.721, 733 and 791. A few were also operated by the US Eighth Air Force.

Twelve USAAF squadrons trained with the Vengeance but re-equipped with North American A-36s and Republic P-47s by the end of 1943. A projected single-seat Model 86 did not materialise. The substantial production run was characterised by one US general as 'a shining example of the waste of material, manpower and time' and the Vengeance was often similarly maligned by aircrew. Although reputed to be awful to fly, experienced pilots found it viceless, extremely strong and fully aerobatic.

Only one A-31 Vengeance IA ('EX999'/A27-99) is preserved today, at the Camden Museum of Aviation in New South Wales, Australia, although at least two others are stored in a derelict state, also in Australia.

The first XP-54, with 'Swoose Goose' insignia under the cockpit. (Wright Field)

A-31

One 1,600hp Wright Cyclone R-2600-19 fourteen-cylinder air-cooled radial engine.

Crew: two

Armament: Six 0.30in guns, four in the wing and two flexible in the rear cockpit plus bomb load of 1,500lb.

Span 48ft 0in; length 39ft 9in; height 15ft 4in; wing area 332sq ft.

Weight empty 9,725lb; maximum gross 14,300lb.

Maximum speed 275mph/11,000ft; cruising speed 235mph; climb 11.3min to 15,000ft; service ceiling 22,500ft; maximum range 1,400miles (320US gal fuel capacity).

Model 84 (XP-54)

On 18 December, 1939, the USAAC initiated an informal design competition for a single-engined pursuit interceptor and thirteen companies were invited to tender proposals under the encompassing 'Request for Data R40-C'. Nine designs were submitted for appraisal by the Wright Field board on 15 May, 1940, and three were authorised for procurement 16 days later. First place in the competition went to Vultee's Model 78 and a contract for two XP-54s was awarded on 22 June. A cranked wing design, the XP-54 was predicted to achieve 510mph at 20,000ft and reach that altitude in six minutes. Runners up Curtiss and Northrop also received prototype contracts for their XP-55 and XP-56 respectively.

All three were pushers powered by the proposed Pratt & Whitney X-1800-A4G (H-2600), a 1,850hp liquid-cooled twenty-four cylinder engine with contra-rotating propellers. The pusher configuration appeared to offer lower drag, for the effects of the propeller slipstream on the fuselage were eliminated, and improved visibility and armament also seemed possible. However, Pratt & Whitney discontinued work on the X-1800 in October 1940, and the 2,300hp Lycoming XH-2470, under development for the Navy, was substituted although provision was made for a change to the Wright Tornado R- 2160. In the event, neither the engine nor design (the P-68) materialised.

Vultee was also instructed to make provision for a pressurised cabin, add turbosuperchargers and change the nose armament from six 0.50in guns to two 0.50in and two 37mm cannon. All these revisions transformed the XP-54 into a high-altitude bomber interceptor and raised the gross weight from 10,000lb to 18,000lb. Reflecting the extensive remodelling, the design was renumbered Model 84.

The final aircraft featured a double-tapered wing, also used on the Vengeance, designed around a newly-developed NACA ducted wing section which allowed air to enter at the root, pass over oil and coolant radiators within the wing, and exit through the trailing edge of the flaps.

The nacelle-type fuselage incorporated two other new features. Because of the different muzzle velocities of the cannon and machine-guns, the entire nose section was mounted on the nose-wheel leg pivot shaft which enabled the cannon to be elevated without change in flight attitude and the machine-guns

to be depressed. The aiming was accomplished by the pilot through a compensating gun sight.

The pressurised cockpit requirement was solved by installing a fixed canopy, which solved sealing problems. However, this in turn led to the question of pilot access and exit, so the seat was attached to a hinged section beneath the cabin and the pilot literally rode up into the cockpit. In an emergency,with altitude to spare, the seat assembly was catapulted clear of the 12ft propeller. Flight control cables were routed around the cockpit floor opening and an inverted U column was employed to support the control wheel.

With these engineering challenges, it is not surprising that the prototype delivery date slipped substantially from the contracted July 1942. The first XP-54 (41-1210) was not flown until 15 January, 1943, by Frank Davis, from Muroc Dry Lake (now Edwards AFB). The 31-minute flight was uneventful although the Curtiss propeller malfunctioned and was subsequently replaced by a Hamilton Standard type. By 11 March, ten flights had been made but the engine showed metal traces in the oil and the aircraft returned to Downey for an engine change. Further testing was done at Ontario AFB, California, for a total of 63 hours and 86 flights, before the XP-54 was flown to Wright Field on 28 October. However, the engine developed serious problems and was returned to Lycoming, but repairs proved prohibitive and the engine was scrapped.

The first XP-54, now known as the 'Swoose Goose', therefore acted as a source of spares for the second aircraft (41-1211). A further change from two Wright turbosuperchargers to a single experimental General Electric XCM model caused additional delay and this aircraft did not fly until 24 May, 1944, on a 20-minute flight from Downey to Norton AFB, San Bernardino, California. The engine/turbosupercharger combination was unsatisfactory and they were returned to the manufacturers.

By then, the Lycoming programme had been abandoned by the Navy and initial flight tests had revealed that the XP-54 performed well below estimates. Although another engine was installed in the second aircraft, it was not flown again. The nose section was sent to Eglin for armament tests (it had not been fired in the air) and the airframe scrapped. The first prototype was structurally tested to destruction at Wright.

An Allison W-3420 was considered as an alternative powerplant along with an unspecified jet engine, but both proposals were rejected on grounds of cost.

One 2,300hp Lycoming XH-2470-1 twenty-four-cylinder liquid-cooled inline engine with turbosuperchargers.

Armament: Two 0.50in M-2 machine-guns and two 37mm T-12/13 cannon in nose.

Span 53ft 10in; length 54ft 8$^{3}/_{4}$in; height 14ft 6in; wing area 456sq ft.

Empty weight 15,262lb, maximum gross weight 19,337lb.

Maximum speed 381mph at 28,500ft; 290mph at sea level; initial climb 2,300ft/min; 26,000ft/17.3 min; service ceiling 37,000ft; range (estimated) 350 miles at 18,233lb (223US gal fuel capacity).

Model 90 (XA-41)

At the request of the USAAF, Vultee completed a design study of a single-seat ground support aircraft around a 3,000hp Pratt & Whitney Wasp Major XR-4360 twenty-eight-cylinder radial engine in mid-1942. A contract for two XA-41s (43-35124/35125) was placed on 10 November, 1942, but after a satisfactory mock-up inspection the following March, the intended role was changed from dive-bomber to low-level attack. This caused a delay and on 30 April, 1943, a new contract under the same designation was issued for two prototypes and one skeleton airframe.

By the end of September, the first XA-41 was almost half-complete but the USAAF no longer required such an aircraft as existing fighters had demonstrated the ability to perform the role. The programme was scheduled for cancellation but Gen O P Echols, its originator stated that it represented the latest in ground attack development and offered the earliest flight test-bed for the X-Wasp engine. Therefore, one prototype (already 75 per cent complete after an expenditure of $2.3 million) was authorised on 20 November. Vultee did undertake a study to convert the XA-41 to a long-range fighter, but in view of the results this course was abandoned.

The cockpit of the XA-41 was positioned well forward which offered excellent visibility and the deep fuselage housed a large bomb bay and fuel tanks. The wings featured a straight leading edge and a trailing edge with forward sweep and eight degrees dihedral on the outer panels. The inner wing section accommodated an inward retracting undercarriage.

Piloted by Frank Davis, the XA-41 made its first flight from March Field, California, on 11 February, 1944, and almost daily flights followed. These showed the XA-41 to be 'delightful' in the air with a better than estimated performance. The XA-41 was accepted by the USAAF on 15 June and its 60th flight was made on 16 July when it was ferried to Eglin for evaluation. Although it could out turn the North American P-51B, the XA-41 was considered unsuitable for low-level attack because of its inability to control aerial combat and the increased fire power did not outweigh its speed deficiency. This report, coupled with the preference for twin-engined heavy attack aircraft and the pace of events in Europe, sealed the fate of the already tentative project.

Following trials by the Navy at Patuxent River, the XA-41 was delivered to Pratt & Whitney for tests in connection with development of a variable-speed supercharger. Subsequently purchased by them, the prototype was re-registered NX60373 for further engine development before being scrapped at Hartford in 1950.

One 3,000hp Pratt & Whitney Wasp Major R-4360-9 twenty-eight- cylinder air-cooled radial engine

Armament: Four 0.50in Browning machine-guns and two 37mm M-9 cannon in the wings plus two 500lb bombs. Alternatively, eight guns in various combinations and up to 3,200lb of bombs.

Span 54ft 0in; length 48ft 8in; height 4ft 6in; wing area 540sq ft.

Weight empty 13,400lb; maximum gross weight 24,200lb.

Maximum speed 363mph at 15,500ft; 333mph at sea level; climb 2,730ft/min at sea level; 10,000ft/4.3min; service ceiling 27,000ft; range 800 miles (1,000lb bomb load); ferry range 3,000 miles (1,140US gal fuel, extra tanks).

The XA-41 (43-35124), probably at March Field in 1944. (US Air Force)

Vultee Production, Selected Aircraft

V1

All except msn 1 were V1-A; msns 24/27 were built at Downey (but not in that order), the remainder at Glendale.

msn	*regn*	*remarks*	*msn*	*regn*	*remarks*
1	NX12293	Evaluated by American Airlines, sold to AA 7.5.34 as NR12293, to Spain 1937 as F-AQAP	12	NC13774	V1-AD; Superior Oil Co, later Phillips Petroleum, to Spain via Mexico (XA-BET) 1937
2	NC13764	American Airlines 18.7.34, to Spain 1937	12A	NC14249	V1-AD; United Gas Public Service, Texas, WO Ferris, Texas, 12.6.36
3	NC13765	American Airlines 26.7.34, to Spain 1937	14	NC14250	Examiner Printing Co (Hearst) 18.1.35, WO San Simeon, California 24.2.38
4	NC13766	American Airlines 8.6.34, to Spain 1937	15	NC14251	V1-AD; Nevada Gas; Lang, Transportation Co, Los Angeles; to Spain 1937
5	NC13767	American Airlines 21.8.34, WO Little Elm, Texas, 29.1.36	16	NC14247	Canadian-Colonial Airways 18.2.35, re-reg CF-AWQ, re-reg NC22077 23.2.39 Edwin Link; Alaska Star Airlines; George H. Armitage WO nr Somerset, Pennsylvania, 20.3.48
6	NC13768	American Airlines 9.34, to Spain 1937 as F-AQAM	17	NC14248	Bowen Air Lines 26.2.35; American Airlines 15.2.36; to Spain 1937. Wheels-up landing at Beauvistille 9.37
7	NC13769	American Airlines 14.9.34, to Spain 1937	18	NC14252	W P Fuller Co 5.3.35; later RW Lyons, National Sodium, Morrison-Knudsen; to Aero Transportes SA, Mexico City, 19.1.41 as XA-DIL, later XB-MEA
8	NR13770	Built for Lt-Col George R Hutchinson for proposed all-freight New York – London – Moscow Air Lines Inc but not delivered; Harry Richman *Lady Peace*; to Spain 1937 *Capitan Haya*, scrapped 1953	19	NC14253	Bowen Air Lines, 14.3.35; American Airlines 15.2.36; to Spain 1937
9	NC13771	V1-AD; Dr Carl P Jones, Grass Valley Mining Co, California 16.12.34, to Burma as XY-AAF, to Republic of China 3.2.40			
10	NC13772	American Airlines 29.9.34, to Spain 1937 as F-AQAO			
11	NC13773	American Airlines 21.12.34, to Spain 1937			

20	NC14254	V1-AD; W S Stephenson; sold to Britain 3.5.35 (as a demonstrator) but damaged in unloading and WO
21	NC14255	V1-AD; Richardson & Watts 5.4.35; used by Crusader Oil, NY; to Spain 1937
22	NC14256	V1-AD; Errett L Cord 5.9.35, to United Kingdom (Ricketts); to Spain 1937 EC-48-E LAPE
23	NC16000	V1-AD; Aviation Manufacturing Corp, Chicago 28.2.36; sold to broker for re-sale to Spain but not shipped; to Chinese Govt 3.2.40
24	NC17325	Vimalert 2.1.37, shipped to Spain but captured at sea by Nationalists
25	NC16099	V1-AD Special, 850hp Wright SR-1820-G5 Cyclone. Examiner Printing Co (William Randolph Hearst) 3.4.37, to Compañia de Transportes Aéreos Limipada, Panama City 20.7.40, operated in Panama and Honduras 1941-44 by Compañia de Transportes Aéreos Gelebert (Panama) as RX-19 (7/41), AN-ABI 11/43, RX-158/HP-158 G.A. Valderrama. Re-sold to USA by TACA in 1960 and restored as *Spirit of Pueblo* 1971, currently preserved at Virginia Aviation Museum, Sandston, Virginia.
26	NC17326	Vimalert 12.36 for Spain but not shipped; to Chinese Govt. 3.2.40
27	URSS-N208	V1-AS, Amtorg, flown Santa Monica to Moscow 1936 by Levanevskii and Levchenko

(One additional airframe was exported to the Soviet Union, as an instructional tool before V11-GB production)

At least four other Spanish V1-As received temporary French registrations as follows: F-AQAF, F-AQAG (damaged Toulouse 29.8.37), F-AQAK (destroyed at Toulouse 29.8.37),

V11 and V12

(All but the first two built at Downey)

Designation	*Vultee-built*	*Licence-built*	*Remarks*
V11	1		msn 28 WO 19.9.35
V11-A	1		msn 29 converted as V11-T
V11-A (China)	1		msn 30
V11-G (China)	29		msn 36/64, assembled in China
V11-GB (USSR)	4		msn 32/35, 33 to V11-GBS
V11-GB (USSR)		31?	BSh-1, designated PS-43 by Aeroflot
V11-GB	1		msn 31, to V11-GBS
V11-GBT (Turkey)	40		msn 65/104. 73 crashed Downey and rebuilt, 78 WO 1.5.39, 96 WO 25.4.39, 99 WO 1.5.39
V11-GB2 (Brazil)	26		msn 105-130, last as -GB2F
V11-GB (USAAC)	7		msn 132-138, 2 converted to XA-19
V12 (AB-2)	1		msn 131, to Pratt & Whitney
V12-C (China)	1		msn 143, not del'd
V12-C (China)		25?	assembled in China, possibly not all completed
V12-D (China)	1		msn 144
V12-D (China)		6?	Three assembled by HAL (51 parts sets shipped)
Totals:	113	62	

Model 54A

Contract Number	*Type*	*Number*	*Serial Numbers*
13219	BT-13	300	40-810/1109
15569	BT-13A	2,500	41-1211/1710 41-9587/11586
Peru	BT-13A	12	
19042	BT-13A	2,580	41-21162/23161 42-1164/1743
	BT-15	320	42-1744/2063
24630	BT-13A	1,057	42-42201/43257
	BT-15	943	42-41258/42200
	SNV-1	700	BuA ***
31383	BT-13A	900	42-88674/89573
	BT-13B	1,125	42-89574/90678
	SNV-1	450	BuA 34135/34584
37921	SNV-2	650	BuA 44038/44187 (ex-44-32011/32160) BuA 52050/52549 (ex-44-31511/32010)
Total		11,537	
		plus 1 skeleton aircraft (msn 2)	
		11,538	

Total by type : BT-13 (300), BT-13A (7,049), BT-13B (1,125), BT-15 (1,263), SNV-1 (1,150), SNV-2 (650).

*** Known SNV-1 serials are 02983/03182 (200), 05675/05874 (200), 12492/12991 (500). However, this totals 1,350 aircraft, not 1,125; thus one batch was apparently not taken up. Four hundred and thirty SNV-1s allocated 41-9980/10409, BuA 03022 confirmed ex-41-10886.

Barkley-Grow Aircraft Corporation

CF-BQM spent nearly 40 years in the Canadian bush service until rescued from destruction for the Aerospace Museum, Calgary, Alberta. (Stephen J Hudek collection)

Archibald S Barkley helped build some of the Wright brothers early gliders, then worked briefly with the Wright and Curtiss companies before joining the US Army and serving overseas during the First World War. On his return, he worked for several manufacturers in the Detroit area, including Verville, Stout, and Ford. During this period, Barkley conceived a new type of wing structure consisting of two series of V-shaped stringers or spars running lengthwise along the top and bottom of the wing, joining to form an X shape, and thus dispensing with ribs or bulkheads. To prove his patented construction method. Barkley built a twin-boom, four-seat cabin monoplane in 1931 called the Warwick. Although it crashed on a test flight, the wing survived intact vindicating Barkley's theory.

In 1936, Barkley joined forces with Harold B Grow and formed the Barkley-Grow Aircraft Corporation at City Airport, Detroit. Grow had served as a commander in the Navy in France during the war and in 1924, as a member of the US Naval Mission, had helped organise the Peruvian Air Force and remained in that country until 1930. On his return to the United States he founded an aviation broker concern, Grow, Joy & Co in Detroit.

Chief engineer of the new aircraft company was W F De Groat, with Dwight C Maier as project engineer. Together with Barkley, they designed an eight-seat twin-engined transport with a non-retractable undercarriage, the T8P-1. First flown in 1937, the sound design attracted considerable attention but few orders, because of competition from the Beech 18 and Lockheed Electra series, both of which featured retractable undercarriages. Only nine aircraft are known to have been completed. Seven of these were sold in Canada via the Canadian Car and Foundry Co Ltd which had negotiated world-wide sales rights outside the United States.

Facing financial difficulties, Barkley-Grow was acquired by the Aviation Manufacturing Corp (AVCO) in June 1940 and absorbed into Vultee. The factory was used for aircraft subassembly work during the war.

Barkley-Grow Aircraft

T8P-1

Barkely and Grow joined forces in Detroit in 1936 to produce a light twin-engined transport designed around the patented Barkley multi-spar metal wing. Designated T8P-1 (Transport, 8-place, first model), it closely resembled the contemporary twin-finned Beech 18 and Lockheed Electra series. The prototype (NX18388) was rolled out in April 1937 and first flown by Frank Cordova.

The T8P-1 was of all-metal semi-monocoque construction with the cellular-spar and stressed-skin covered wing built in three sections with trailing-edge flaps. A non-retractable undercarriage with streamlined fairings was fitted, claimed to ease the pilot's workload and save weight, and although a retractable system was offered as an option, none of the nine known aircraft built were completed to this standard. Power was provided by two 400hp Pratt & Whitney Wasp Jr SBs, enclosed in NACA cowlings and driving Hamilton Standard fixed-pitch propellers. The fuselage entry door was on the starboard side and accommodation was for seven passengers and one pilot, reduced to six passengers with two crew. Two baggage compartments, one in the nose and one in the rear cabin, held up to 250lb and 180lb respectively. Normal fuel capacity was 160US gal in two wing tanks, but a 30US gal tank in each nacelle could be installed. A lavatory plus furnishings to airline specifications was standard.

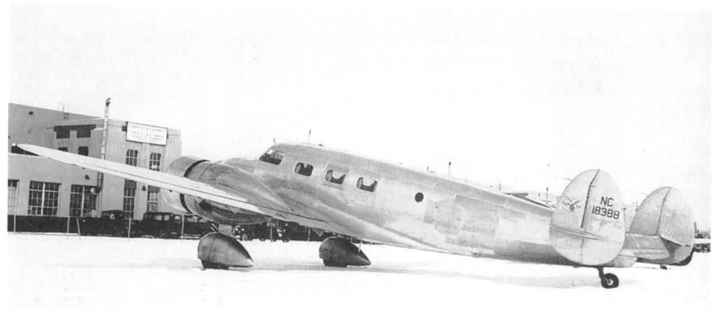
Most of the subsequent testing was done by Lee Gehlbach and ATC 662 was awarded on 30 October, 1937, and the prototype was then taken on a nationwide sales tour. Priced at $37,500, the aircraft created considerable enthusiasm but few orders as it outperformed the lower-priced Beech 18 only with regard to short-field performance. The prototype was lighter than pro-duction aircraft, which had larger tail fins and differed from each other in details. Landing lights, for example, were installed in the nose, wings, or not at all and all the engine cowlings had minor differences.

Although the first production aircraft was reported sold to the General Aviation Corp in Denmark (which was interested in licence rights), it was delivered to Alex Papana. The well-known Romanian pilot intended to use it for a flight from New York to Bucharest. After two attempts failed, the aircraft (with extra fuselage tanks to bring capacity to 1,150US gal) was sold to Peru. Flown by brothers Capt Victor and Cdr Humberto Gallino of the Peruvian Air Force, it left Floyd Bennett, New York, on 29 October, 1940, for a nonstop 4,000-mile flight to Lima. After 25 hours, lack of fuel forced the brothers down at Salinas De Punta Arenas, Ecuador, 700 miles short of their destination, which they reached the following day.

Another (msn 7/NC18470) saw service with Admiral Byrd on his third Antarctic expedition in 1939. On its return to the USA two years later, the aircraft was found to be extensively corroded by salt water and it was scrapped.

Canadian Car and Foundry Co Ltd, Montreal, acquired the world-wide sales rights outside the USA and imported seven (including the prototype) into Canada. One was sold to the RCAF and three were almost given away to Yukon Southern Air Transport in a lease-purchase deal for one dollar each made by the airlines's president, Grant McConachie. The T8P-1 had been certificated for use on Edo 65-9225A floats, with an additional central fin, but not on skis (although the manufacturer claimed this was so). Thus, Can-Car designed ski fittings which were tested by Yukon Southern but it was two years before official approval was received.

In Canada, the T8P-1 proved itself a capable and popular bush aircraft free of major flaws and was approved for up to ten passengers with a reduction in fuel load. Six were used by Canadian Pacific Air Lines until replaced by DC-3s in 1949. The four survivors were passed to other bush operators and one (msn 8/CF-BQM) was in service until 1970. Salvaged after an



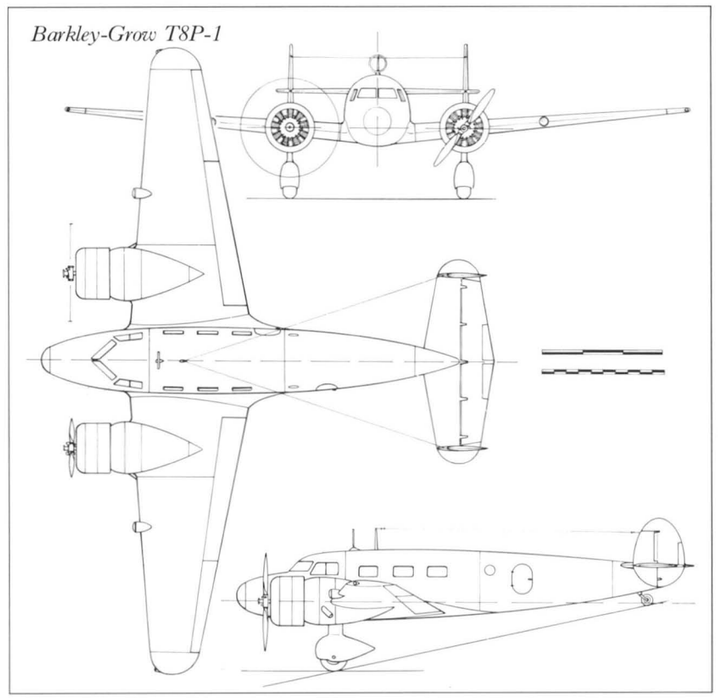
The prototype T8P-1, NC18388, at City Airport, Detroit, during winter 1937-38. (John Wegg collection)

The first production T8P-1, for Alex Papara. The cabin windows have been discarded because of the extra fuel tanks installed in the fuselage. (Robt F Pauley collection)

Admiral Byrd's T8P-1 NC18470 with US Antarctica Service titles and USAAC-style roundels under the wing. (Robt F Pauley collection)

accident, it has been preserved but the remains of four other T8P-1s also remain in Canada.

Barkley-Grow planned to offer a bomber-trainer version (designated BT-2) to South American air forces (particularly Peru), but the company was sold before any further work took place.



Two 400hp Pratt & Whitney Wasp Jr SB (R-985) nine-cylinder air-cooled radial engines.

Span 50ft 8 3/4 in; length 35ft 8in; height 9ft 7 1/2 in; wing area 354sq ft.

Weight empty 5,365lb; gross weight 7,950lb (initial), 8,250lb (production), 8,750lb (msn 3 onwards), 9,200lb (seaplane).

Maximum speed 225mph at 5,000ft; cruising speed 204mph at 5,000ft; initial climb 1,420ft/min; service ceiling 24,000ft; range 470-630 miles (160-220US gal fuel capacity).

Barkley-Grow T8P-1 Production

msn

1 NX18388; CF-BVE Prairie Airways, Moose Jaw 9/41; CPAL; NC18388 Frank Ambrose, LI, 2/45; Northern Airlines, Nettley, Manitoba; one wing used to repair CF-BQM and remainder acquired by Harry Whereatt, Assiniboia, Saskatchewan.

2 YR-AHA Alex Papana; OB-GGK, to Peruvian Air Force 2nd Staff Sqdn until WO in hangar fire 1942.

3 CF-BLV Yukon Southern Air Transport 2/39 *Yukon Queen*; CPAL; H R Peets, Edmonton 11/49; Associated Airways, 1951; Pacific Western Airlines; crashed on take-off 1/60 at Peace River, Alberta, considered unrepairable and abandoned; fuselage recovered in 1982 by Aerospace Museum Association, Calgary.

4 CF-BMG Yukon Southern Air Transport 2/39 but not delivered until 1/40 *Yukon King*; accident 4/41 at Watson Lake but repaired; Quebec Airways 1942; CPAL; sank at Port Alberni, British Columbia 1/2/47, salvaged and scrapped 8/47.

5 RCAF 758 9/9/39, No.12 Sqdn; CF-BMV Maritime Central Airways 1940, destroyed in rescue attempt for USAAF B-17 crew in Greenland 12/42.

6 CF-BMW Yukon Southern Air Transport 1/40 *Yukon Prince*; CPAL; Associated Airways, Edmonton 12/49; Pacific Western; Northland Airlines 1956; forced landing at Nettley, Manitoba and some parts recovered by Harry Whereatt.

7 NC18470 Byrd Antarctic Expedition *Explorer* 1939-41, scrapped due to corrosion.

8 NX26400; CF-BQM Mackenzie Air Service, Winnipeg 5/40; CPAL 1942; Associated Airways 1950; F R Baker, West Vancouver 1958; Sioux Narrows Airways; Parson Airways; Northland Wild Rice Ltd; Northland Airlines; Midwest Airlines; sank at moorings at Norway House, Manitoba, late 1970; Dr J April, Montreal 1971; abandoned 1977; Aerospace Museum Association, Calgary 5/79 and preserved.

11 NC26496; CF-BTX Mackenzie Air Sevice 4/41; CPAL; forced landing near Katawa Lake, 11/45 and remains retrieved 1989 for restoration.

No details are known for msn 9/10, however registration CF-BVB was reserved for a T8P-1 but not taken up.

Convair

The War Years

Following the formal merger of Consolidated and Vultee, approved on 17 March, 1943, Convair * consisted of thirteen manufacturing, modification, research, and operating divisions in ten states. Employment at all the divisions peaked at 101,624 in December 1943 and that year Convair produced 10,496 aircraft, more than any other United States manufacturer. Between Pearl Harbor and VJ Day (August 1945), Convair built 28,004 aircraft. The equivalent of approximately 5,000 more were built as spare parts. In terms of wartime contracts received in dollar value, Convair came fourth, behind General Motors, Curtiss-Wright, and Ford.

The top producer was the former Consolidated plant at San Diego where peak production was reached in January 1944. During that month 253 B-24s, seventy-four PBYs and the first production Coronado came off the assembly lines. Before the war, subcontracts had formed only a small proportion of the industry's total output. However, by 1943, San Diego was building B-24s with parts supplied by nearly one hundred concerns. Congestion in the San Diego area led Convair to establish small 'feeder' shops all over California from December 1942 and eventually there were eleven working for San Diego employing 1,700 people, most of them women. Typical products included bulkheads, upholstery, electrical harnesses, sheet metal subassemblies, and plexiglass mouldings. Employment at San Diego remained close to 45,000 from summer 1942 to April 1943, thereafter dropping slowly to 35,000 over the next two years. After

Convair's finest hour. The world's three fastest aircraft in their respective classes (fighter, F-106A; bomber, B-58A; and airliner, Model 880) pose together near Edwards AFB, California, in 1960. (Convair)

* The formal merger, following the acquisition of Consolidated by Vultee in November 1941, produced Consolidated Vultee Aircraft Inc. However, by June 1943, this had already been abbreviated to Convair, a name that gradually came into accepted use although it was not officially registered until 1954.

May 1945, the force plummeted to 3,760 by the end of the year. During 1945, an 8,500ft concrete runway was built at Lindbergh Field, jointly financed by Convair and the US Navy. A contract for 500 B-32s was cancelled in May 1945 and only one was completed. In addition, Camp Consair was set up adjacent to the Lindbergh Field plant to train mechanics for the Liberator.

The Fort Worth plant officially opened on 17 April, 1942. As the Ford factory was not yet in production, the first batch of B-24s was assembled from San Diego-supplied components. The first Fort Worth-built B-24 Liberator was accepted on 1 May, 100 days ahead of schedule. Fort Worth eventually produced 3,034 Liberators, including C-87 and AT-22 variants. Production rates exceeded two hundred a month by November 1943 and employment peaked at 30,574 during the same month. In August 1942, Fort Worth was designated responsible for the detailed design and construction of two XB-36s (preliminary design and a mock-up had been completed at San Diego) but throughout the war the project rated a low priority and the prototype had not been completed by the end of the war. Fort Worth's second production contract was for the B-32 Dominator; three XB-32s had been originally built and flown at San Diego. Work began in January 1944 and the first B-32 was delivered to the USAAF on 19 September, 1944. Only 114 Dominators were completed at Fort Worth, before all further production was cancelled in September 1945. By December, the payroll had shrunk to 6,200 workers, mostly engaged on the B-36 programme.

Early in the war, a plan was drawn up whereby Nash-Kelvinator would build Vought-Sikorsky flying-boats in a government-built plant on Lake Pontchartrain, New Orleans, Louisiana. However, in January 1943, the Navy announced that Consolidated Vultee would take over the factory, then nearing completion, to build P4Ys (Consolidated Model 31). Tooling for production started that spring but again plans changed. The P4Y programme was abandoned and instead a decision was taken to transfer PBY production from San Diego to New Orleans. The first PBY-5 Catalina assembled at the new Convair plant (a

After the takeover of Consolidated by Vultee, the former's eagle logo was retained. Convair also used variations on this theme, an outspread eagle immediately postwar, then a more stylized version in later years.

PBY-5) was accepted in April 1944. The remainder of the PBY-5 contract was cancelled and in its place, 234 amphibious PBY-5As and PBY-6As were produced. Canadair, in Montreal, supplied 119 hulls and 172 wing sections for these aircraft. Peak employment at New Orleans was 6,487 in February 1945 and modification work was also done for the Coronado. The factory was closed in September 1945 and returned to the government.

The first Consolidated post-production modification centre was established at Tucson, Arizona, and was initially known as a dispersal base. In August 1942, it was re-organised as a division and employment peaked at 4,285 workers in February 1944. The facility had six assembly lines installing improved gun turrets, fitting disposable fuel cells, or meeting theatre commander requests for seating changes for crews, for B-24s and Boeing B-29s. Up to September 1945, when it was closed, 4,103 aircraft passed through for modification.

During winter 1942, Consolidated Vultee set up a similar centre at Elizabeth City, North Carolina, to handle naval aircraft, including PBYs, PB2Y Coronados, and North American PBJ-1 Mitchells. A housing shortage in the area was alleviated by anchoring the 75-room *Amphitrite*, an old East Coast resort attraction, offshore. A maximum of 1,200 workers were employed in December 1943 and the facility was closed in September 1945.

A third modification centre was established at Louisville, Kentucky, for B-24s and closed in September 1945.

Besides the Stinson Division at Wayne, another smaller division was created in Michigan in 1942 when Consolidated Vultee took over the Stout Engineering Laboratories Inc at Dearborn. Formed by William B Stout, who had pioneered thick-winged metal monoplanes in the United States and designed the Ford Tri-Motor, the facility was given over as a research centre for light aircraft that could be converted for use as automobiles. Stout was retained to develop the 'air car' concept and towards the end of the war the Gwinn Aircar was evaluated by the division. The division was subsequently moved to Nashville, then San Diego.

The other divisions consisted of Vultee Field, Downey, which produced Valiants and Vanguards, plus components for B-24s, B-32s, PB4Y-2 Privateers, and Lockheed P-38 Lightnings; Nashville, originally built for Stinson and taken over by Vultee, built the Vengeance and Vigilant, plus parts for the B-24, P-38, and TBY-2 Sea Wolf; Miami (Intercontinent Aircraft) which built sections for A-35 Vengeances, B-24s, PBYs, Chance Vought F4U Corsairs and TBY-2s, and P-38 Lightnings up to the end of May 1945; and Allentown, Pennsylvania (the old Mack Truck plant), used for production of the TBY-2 from early 1944 until July 1945, then closed late that year; and Consairway.

Consairway

When Pearl Harbor was attacked on 7 December, 1941, there were only twenty-seven four-engined transports in the United States, including eight Pan American Airways Boeing 314s and eleven LB-30s, which bore the brunt of overseas air transport demands for many months. In April 1942, Gen 'Hap' Arnold decided to start regular services from California to the South Pacific with two repossessed RAF LB-30 Liberators. Consolidated was selected by the new Ferrying Command to conduct the operation as it had a pool of experienced pilots who had ferried thirty-six PBY Catalinas from San Diego to Manila for the Netherlands East Indies Air Force during summer 1941. Also, in November 1941, an LB-30 (AL527) captained by Richard A McMakin, chief pilot of the company's flight and service department, had made a crew rescue

flight from San Diego to Hickam Field, Honolulu, in 12hr 15min. The return to California the next day was made in 11hr 40min, considerably faster than Pan American's prewar flying-boat services.

Dick McMakin was picked to direct what became Convair's Consairway Division (Consolidated Airways Inc) and during 2-8 April, 1942, he made a 14,600-mile survey flight on the California–Australia route. For that feat he received the Air Medal posthumously; he was killed testing the first XB-32 at San Diego on 10 May, 1943. Regular flights began on 23 April, routeing San Diego–Hamilton Field, California, – Hickam–Canton Island–Nadi (Fiji)–Plaines des Gaiacs (New Caledonia)–Williamstown. In September, the terminus was changed to Amberley Field, near Ipswich, Queensland, (7,200 miles from San Francisco) and the California headquarters was shifted to Hamilton. The mainland operations centre was again moved on 15 December, 1943, from Hamilton to Fairfield-Suisan (now Travis AFB). In August 1942, Consairway began carrying United Air Lines' captains as crew members to familiarise them with the route and the following month, United started a second contract service over the Pacific.

By 1945, Consairway had seventeen Liberator transports (CB- 24s, C-87s and LB-30s) in service and that May they averaged 15hr 11min flying time daily. Seven aircraft had logged over 10,000 hours. The record time for the California–Australia round-trip was 3 days 17 hours and payloads of over 10,000lb had been carried on occasion. For many years, until the Douglas DC-7 was introduced, a Consairway LB-30 held the Honolulu – San Francisco speed record. When Consairway closed on 15 December, 1945, its manager, Robert S. Mitchell, reported that it had achieved over 101 million ton-miles of cargo and had flown more than 299 million passenger-miles. Three fatal accidents were suffered but the service was considered so successful that it was planned to make it a commercial one after the war. However, the conflict of interest with a manufacturer operating an airline was obvious and the plan was subsequently abandoned. Consairway's contract was officially cancelled on 1 January, 1946. Many key personnel were involved in the formation of Pacific Overseas Airlines Corporation in October 1945.

The Postwar Decline and Rise

The cessation of wartime contracts in 1945 brought the aircraft manufacturing industry to a state of collapse. Convair's payroll dropped to 12,822 by March 1946 with the closure of San Diego's Plant 2, Tucson, Elizabeth City, Louisville, New Orleans, and Allentown. The Stinson Division at Wayne quickly converted to production for the Model 108 Voyager and for a year or so enjoyed the distinction of being the only unit making money. The three main divisions, San Diego, Fort Worth, and Vultee Field were occupied with the Convair-Liner, B-36, and XF-92A respectively. The major problems were to retain sufficient experienced workers and generate working capital. One Vultee project was development of a plastic and aluminium packaged home. In January 1946, a controlling interest was purchased in ACF-Brill Motors Company of Philadelphia, which made buses, and its wholly-owned subsidiary, the Hall-Scott Motor Car Company of Berkeley, California, which manufactured automobile and marine engines. The Nashville plant was converted to produce kitchen ranges and freezers for the Crosley Corporation (an AVCO affiliate) and buses for ACF-Brill.

During late summer 1946, there were talks to merge Convair's aviation divisions into Lockheed, with AVCO withdrawing and maintaining Nashville and ACF-Brill. Terms were agreed to by AVCO chairman Victor Emanuel, Lockheed president Robert E Gross and Irving Babcock, chairman of Convair since Girdler's resignation in April 1945. However, the grounding of the Lockheed Constellation in July caused the proposal to lose momentum and it was never put to a stockholder vote.

At San Diego, the Convair-Liner, which although ultimately successful, drew Convair deep into debt. From the outset, it was realised that the programme would initially lose money but it was beset with rising engineering and tooling costs and unforseen delays. The initial large orders from American Airlines and Western Air Lines were not repeated as there were few other customers who could afford a new 'DC-3 successor' when the aircraft it was supposed to replace was so readily available. Competition with Martin forced Convair to underprice the Convair-Liner and it fell into the trap of tailoring each aircraft specifically for a customer. Material shortages and a 101-day strike in 1946 brought man-hours up to 68,000 hours from the estimated 30,000 per aircraft for the first batch of 168. Subsequently, this figure was reduced to 32,200 hours for each of the Model 340s built. But the losses ($32.3 million in 1947) brought about a change of ownership.

Convair was a company whose potential assets appeared to outweigh its immediate liabilities. This attraction came to the attention of Floyd B Odlum, president of an investment house called the Atlas Corp, and during summer 1947 he acquired seven per cent of AVCO stock in the open market. Following negotiations, a contract was signed (ratified at a Consolidated Vultee Aircraft Corporation stockholders meeting on 6 November, 1947) whereby AVCO withdrew to manage its Nashville and ACF-Brill interests and Atlas became the controlling shareholder. On 20 November, control of Convair passed to Atlas and Odlum replaced Babcock as chairman of Convair and on 4 June, 1948, LaMotte T Cohu was named president (later vice-chairman). The latter was an ironic turn of events, as Cohu, formerly president of Transcontinental and Western Airlines (TWA) and general manager of Northrop, had been president of AVCO and American until ousted by the Cord takeover. The position of general manager was taken by A P Fontaine, formerly at Stinson, and R C Sebold became director of engineering. Mac Laddon, a Consolidated director since 1931, retired but continued to serve on the board.

Vultee Field was closed in July 1947 and its projects transferred to San Diego. A year later, Stinson closed its doors and on 1 December, 1948, the name, tools and designs were sold to Piper. This left Convair with two manufacturing divisions, San Diego and Fort Worth, and the Ordnance

The last USAF operational unit to fly the F-102A was the 199th FIS, Hawaii ANG, from Hickam AFB, Honolulu. (Gordon Reid)

Aerophysics Laboratory at Daingerfield, Texas. Operated on behalf of the Navy's Bureau of Ordnance since 1945, the latter facility included a supersonic wind tunnel and a ramjet burner test centre for the development of guided missiles.

Through these measures the loss for 1948 was reduced to just under $12 million, but profitable operations returned in 1949 when airliner sales were $24 million and military sales reached $173 million, largely thanks to the B-36 programme at Fort Worth.

During the early 1950s, Convair pioneered the use of the delta wing in the United States, starting with the XF-92A research vehicle which led to the F-102 and F-106. Serious design problems with the F-102 subjected the programme to heavy financial losses in the early days, but Convair persevered with the concept and eventually produced the successful F-106 and B-58 Hustler. At San Diego, considerable research work was undertaken for the Navy with a water-borne fighter, the XF2Y-1 Seadart, and a VTOL fighter for shipboard use, the XFY-1 'Pogo'. Both designs had delta wings. Advanced hydrodynamics were also employed by the XP5Y-1, a four-engined seaplane, which flew in 1950. On 5 September, 1951, a contract was announced for the world's first atomic-powered aircraft, to be developed in cooperation with General Electric. However, this remained a design and engineering study and was not built.

Employment began to rise again in 1949, surpassing the wartime high at Fort Worth in 1951 with 3 1,000 workers. In addition, over 18,000 were at San Diego where besides its own designs, Convair acted as a sub-contractor to Boeing, building B-50 nose sections.

Apart from aircraft activities, the most important military work focused on guided missiles, derived from early research at Downey by the Vultee group. The first missile was a controlled test vehicle, the Gnat, first fired on 2 July, 1945, followed by the supersonic test vehicle Snoot (STV-1/2/3). The STV-3 was developed into the Terrier (XSAM N-7) for the Navy. A separate Guided Missile Division was formed on 1 March, 1951, at San Diego, occupying Plant 2. Ground was broken on 6 August for the first fully-integrated missile production centre in the United States, contracted for by the Naval Bureau of Ordnance, at a site owned by Convair at Pomona, California, east of Los Angeles. This became the Pomona Division when production was moved from San Diego. First launched from White Sands, New Mexico, on 13 July, 1948, the MX-774 Hiroc missile, first developed by Vultee, was the starting point for a long-term project that eventually culminated in the Atlas intercontinental ballistic missile. The MX-774 featured swivelling motors, a separable nose cone, and featherweight construction, all 'firsts' in the field.

On 15 May, 1953, controlling interest in Convair was transferred to John Jay Hopkins, board chairman of General Dynamics Corporation, when General Dynamics acquired 400,000 shares of Convair stock and became the majority shareholder. The energetic Hopkins had started to build his corporation, which included products such as sand and gravel, in 1947 by acquiring the Electric Boat Company of Groton, Connecticut, and, shortly afterwards, Canadair Limited of Montreal (formerly Canadian Vickers). In 1950, Admiral Rickover requested the Electric Boat concern to build the world's first atomic-powered submarine. With Canadair a subsidiary and the *Nautilus* under construction, Electric Boat was clearly inadequate to describe the operations of the company. Thus, in 1952, operations were combined into the General Dynamics Corporation. In day-to-day charge of General Dynamics, whose headquarters was in New York, was chairman and executive vice-president Frank Pace, formerly Secretary of the Army. Gen Joseph T McNarney was placed as head of Convair with John V Naish as executive vice-president. R C Sebold became engineering director for the two Convair aircraft manufacturing divisions at San Diego and Fort Worth.

The name Convair was officially recognised on 30 April, 1954, when it became a division of General Dynamics.

At Fort Worth the main activity now centred around the B-58 Hustler, the world's first supersonic bomber. However, Fort Worth also manufactured tails and outboard wing assemblies for the Boeing B-52, F-102 and F-106 sections, and converted thirty-six Douglas C-54s to SC-54 standard. Pomona worked on the Tartar missile for the Navy and the Mauler and Redeye for the Army.

San Diego was preoccupied with getting the F-102 programme back on track and built a facility at Palmdale (near Edwards AFB) for Delta Dagger fligh-test and acceptance. Around six Convair-Liners were being built every month and in 1955, production switched to the improved 440 model. As F-102 production wound down, the production line was taken over by the F-106 but this was only acquired in relatively limited numbers.

A new Astronautics division, devoted to the Atlas ICBM programme, was created at Kearny Mesa, a few miles northeast of Lindbergh Field and activities transferred from Plant 1. Rocket engine testing was done at Convair's Point Loma and Sycamore Canyon test sites. Total Convair employment now stood at 68,000. In 1956, Convair announced the launch of its jet transport programme which was destined to cause record losses of $425 million, more than twice that suffered by Ford with the disastrous Edsel car. The poor sales of the Model 22 (880) spurred Convair to produce the Model 30 (990), which suffered from development problems which put deliveries a year behind schedule, and competition from the Boeing 720B.

In 1958, Naish replaced McNarney as president of Convair upon the latter's retirement. But a bigger change had occurred the year before when, on 29 April, Frank Pace was voted by the board of directors as president and chief executive officer of General Dynamics, displacing the dying founder. Jay Hopkins, suffering from cancer for several years, died four days later. With the 880/990 costs out of control at San Diego, Convair underwent corporate surgery in May 1961. Naish resigned and five separate divisions were created out of the previous sprawling and unmanageable one. The new quintet of General Dynamic's Western Division consisted of Convair, Astronautics, Pomona, Daingerfield, and Fort Worth. In charge of Western Division was Rhoades MacBride, formerly acting president of Convair following Naish's departure, who reported to GD president Earl Johnson in San Diego. However, ten months later MacBride had gone and the Western and Eastern Division concept was scrapped in order to revert to the old system of having all the separate divisions report to corporate headquarters in New York. The other eight divisions of General Dynamics consisted of Canadair (licence construction of F-104 and CL-44); Electric Boat (submarines); General Atomic (nuclear research); Liquid Carbonic (liquefied gas); Electrodynamics (electric motors); Stromberg-Carlson (telephones and electronics); General Aircraft and Leasing (leases and sales of used aircraft received as trade-ins for jets); and Material Service (building materials and coal mining). Frank Pace left in 1962 and he was succeeded by Roger Lewis, with Werner P Gullander, formerly Eastern Division manager, as executive vice-president. Frank W Davis, once test pilot for Vultee, became president of the Fort Worth Division, with Joseph H Famme occupying the same position at Convair. Jim Dempsey, the first vice-president and general manager of the Astronautics Division was succeeded by Jack L Bowers.

With the end of F-106 production in 1961,work on aircraft at San Diego declined with only a trickle of 990s coming off the line. In addition, Convair received a contract to build tail assemblies for the Lockheed C-141 Starlifter and did research and development work on various advanced projects including pilotless aircraft, guided missiles, supersonic ejection seats, supersonic transports, ground effect take-off and landing aircraft, and portable landing fields. By 1964, employment at Convair had been reduced to 3,200. That year, Convair flew the prototype Model 48 Charger. The counter-insurgency type was the last complete aircraft built at San Diego. The following year, after the sole Charger was lost in an accident, all development work ceased on the programme and Convair merged with the Astronautics Division and Jack Bowers took over the new Convair upon Joe Famme's retirement. Some aircraft activity centred around the certification of the Convair-Liner with Rolls-Royce Dart propeller-turbines and a study of a submersible flying-boat for the Navy, plus a contract to build Lockheed C-5 Galaxy tails. In 1969, Convair began fabrication of McDonnell Douglas DC-10 centre fuselage sections at Lindbergh Field, work that is continued today for the MD-11 derivitive.

B-58A Hustlers move down the line at Fort Worth. Transported on rails eight feet above the factory floor, at the end of the line hydraulic jacks raised built-in platforms out of the floor to make contact with the under-carriage and lower the bomber to the ground. (General Dynamics)

Convair Production Summary

Sea Wolf	(Chance Vought design)	180[1]
Model 100	(Consolidated PB4Y-2, *q/v*)	
Model 101	(Consolidated RY-3, *q/v*)	
Model 102	(XP-81)	2
Model 103	(Stinson built)	1
Model 104	(Consolidated 39, *q/v*)	
Model 105	(L-13)	302[2]
Model 106	(Stinson built)	1
Model 108	(Stinson Voyager, *q/v*)	
Model 109	(XB-46)	1
Model 110		1
Model 111		1
Model 116		1
Model 117	(XP5Y-1)	2
Model 118		1
YB-60	(ex-B-36G)	2[3]
Model 3	(R3Y Tradewind)	12
Model 2	(F2Y-1 Seadart)	5
Model 7-002	(XF-92A)	1
Model 8	(F-102)	1,000
Model 8	(F-106)	340
Model 5	(XFY-1 'Pogo')	3[3]
Model 4	(B-58 Hustler)	116[4]
Model 240/340/440	(Convair-Liner)	1,076[5]
Model 22	(880)	65
Model 30	(990)	37[6]
Model 48	(Charger)	1[7]
	TOTAL	3,151

1 Built at Allentown, Pennsylvania
2 Two built by Stinson Division, remainder by Convair at San Diego.
3 Only one flown
4 Fort Worth built. One additional airframe was completed for static testing.
5 An additional ten built by Canadair at Montreal.
6 Plus one additional airframe for static tests.
7 Last San Diego-built aircraft.

Late production TBY-2 (BuA 30463). (US Navy)

Convair Aircraft

TBY-2 SeaWolf

As a back-up to the Grumman XTBF (Avenger) programme, a second torpedo-bomber design was ordered on 22 April, 1940, from Chance Vought Aircraft. A sole prototype (BuA 2542) was first flown on 22 December, 1941, with a 2,000hp Pratt & Whitney Wasp XR-2800-6. Later it was fitted with an R-2800-2. Delivered to NAS Anacostia in March 1942, the three-seater had two 0.50in and one 0.30in guns and proved to be superior in speed to the Avenger. An interesting feature was an automatic system whereby a single control lowered the undercarriage and flaps, and set the propeller pitch and mixture for landing.

However, Vought was fully occupied with fighter work and a contract for eleven hundred TBY-2s with the 2,100hp R-2800-22 and podded radar underneath the starboard wing was placed with Convair on 6 September, 1943, for its new Allentown, Pennsylvania, factory. The initial production aircraft (BuA 30299) was first flown on 20 August, 1944, by Philip M Prophett and test engineer William F Chana. The first delivery was made to NAF Philadelphia on 7 November, 1944, (BuA 30301) but only a total of 180 were completed (BuA 30299/30367, 30369, 30371/30480) before work was terminated because of the slow rate of production. The Sea Wolf never became operational and the few active ones were mostly used for training.

A proposed 600 of the TBY-3 improved version were also cancelled (BuA 118929/119528).

One Pratt & Whitney 2,100hp Double Wasp R-2800-22 eighteen-cylinder air-cooled radial engine.

Armament: Three 0.50in fixed guns, one 0.50in in power turret and one 0.30in ventral gun.

Span 56ft 11in; length 39ft 2in; height 15ft 6in; wing area 440sq ft.

Weight empty 11,336lb; maximum gross weight 18,940lb.

The first prototype XP-81 (44-91000) with TG-100 propeller-turbine installed. (Convair)

Maximum speed 312mph at 17,700ft; 292mph at sea level; cruising speed 156mph; service ceiling 29,400ft; climb 1,770ft/min; range 1,025miles (with one torpedo).

Model 102 (XP-81)

The first United States propeller-turbine powered aircraft to fly, the XP-81 was the result of a USAAF requirement issued in 1943 for a long-range fighter specifically for Boeing B-29 escort operations in the Pacific. The specification called for a twin-engined aircraft with a 1,250mile operating range, a ceiling of 37,000ft, and a maximum speed of 500mph. In September, Convair's Vultee Field Division submitted a preliminary proposal using a General Electric TG-100 (XT-31) propeller-turbine in the nose and an I-40-GE turbojet fed by intakes shoulder-mounted on the rear fuselage. A closely-cowled annular intake for the TG-100 was located around the four-blade propeller spinner.

Two prototype XP-81s (44-91000/91001) were ordered on 11 February, 1944, and the contract was subsequently modified to include thirteen YP-81s. Chief engineer for the programme was Charles R 'Jack' Irvine, assisted by chief test pilot Frank W Davis. However, because of delays with the TG-100, the first aircraft was rolled out at Downey in January 1945 with a Packard-built Merlin V-1650-7 instead of the propeller-turbine. In this guise the first flight was made from Muroc AAB (now Edwards AFB) on 7 February, 1945.

With the Merlin, P-51 accessories were installed and a P-38J-style beard radiator inlet was prominent below the spinner. The cockpit was designed to be pressurised from air bled from the TG-100 and the ejection seat was developed from that fitted to the XP-54. A thermal anti-icing system was installed and the nosewheel undercarriage was electrically operated. Of all-metal construction, the XP-81 had heavy aluminium-alloy skin flush riveted to the forward third of the NACA aerofoil wing which incorporated two underwing hardpoints for 3,200lb of bombs. Provision was made for six 0.50in Browning M-2 machine-guns, three in each wing, or six T-31 20mm cannon, or any combination thereof. Three fuel tanks behind the cockpit had a capacity of 752US gal and with drop tanks, a total of 1,468US gal could be carried.

Although it was expected that performance would be vastly inferior with the piston engine, the aircraft reached a maximum speed of Mach .74 and climbed to 30,000ft in 7 minutes. Handling was generally good but directional stability was marginal and a 15in fin extension plus a short ventral fin were added. The second XP-81 was fitted at the factory with a rounded fin extension and a long ventral fin.

Continued delays with the TG-100 postponed the first propeller-turbine flight until 21 December, 1945, four months after VJ-Day. Thus the XP-81 was only useful as a research vehicle and the YP-81s were cancelled. But the TG-100 only achieved 1,650shp, well below the expected 2,300shp, and the XP-81 could only reach 492mph, 30mph faster than with the Merlin. Propeller vibration and oil leaks were also a problem and after 69 flights totalling 42 hours with the propeller-turbine the programme ended on 9 May, 1947. The YP-81s, with uprated J33-GE-5 engines were cancelled.

Both prototypes were redesignated ZXF-81 in 1948, indicating research and development test-beds, but it is believed that no further flying had taken place and the following year the airframes were stripped of useful parts. Placed on a photographic and bombing

range at Edwards AFB, the remains are now with the Flight Test Museum.

One 1,650shp (2,300shp est.) General Electric XT-31-GE-1 (TG-100) and 3,750lb st General Electric J33-GE-5.

Span 50ft 6in; length 44ft 8in; height 13ft 6in; wing area 425sq ft.

Weight empty 12,979lb; gross weight 24,650lb.

Estimated performance based on anticipated 2,300shp XT-31-GE-3 engine power:

Maximum speed 478mph at sea level; 507mph at 30,000ft; cruising speed 275mph at 30,000ft; climb 5,300ft/min; service ceiling 47,000ft; range 2,500 miles.

Model 103

With the end of the war in sight, Convair began work on a series of unusual light aircraft designs to cater to the expected private flying boom. The first was an experimental pusher designed by George Spratt which used his controllable wing system devoid of ailerons, moved by the pilot to achieve control. The rudderless four-wheel undercarriage Model 103 (also known as the Spratt-Stout Model 8 Skycar) was built at the Stinson Division in 1944. Powered by a 90hp Franklin 4ACG-199-H3 engine, the prototype (NX22448 msn 1) was tested by the Stout Research Division of Convair at Dearborn, Michigan, then at Nashville by Beryl Erickson and Sam Shannon, and finally at San Diego by Shannon. Following his retirement from Convair and move to Media, Pennsylvania, Spratt went on to design and build his own test vehicle known as the Controlwing 106 (N910Z/msn 1) in 1964.

The Stinson Division-built Model 103. On the fin is a 'Swoose Goose' emblem, similar to the one applied to the Vultee XP-54. (San Diego Aerospace Museum)

Model 105 (L-13)

Designed by the Stinson Division, the Model 105 was intended as a follow on to the L-5 series. Powered by a 245hp Franklin O-425-5, this all-metal general liaison, observation, and ambulance aircraft featured wings that folded back alongside the fuselage, a tailplane that folded upwards, and landing wheels which swivelled round and toed inwards to ease ground handling. The high-lift, two-spar wing of aerofoil NACA 43012A was in two sections, each with 25sq ft of trailing edge area, slotted flaps and a fixed leading-edge slot. These gave a take-off distance of 230ft at 2,900lb with 45 degrees flaps, or 470ft over a 50ft obstacle at 43.5mph.

Without removing the two-blade variable-pitch wooden propeller, the aircraft could be towed in glider fashion at up to 150mph and released in flight, offering a substantial increase in range. Normal crew complement was two side-by-side and a third aft, but up to six could be carried in an emergency. Two doors were installed on the starboard side and one on the port side and the windows sloped outwards to improve vision. Skis or floats could be fitted.

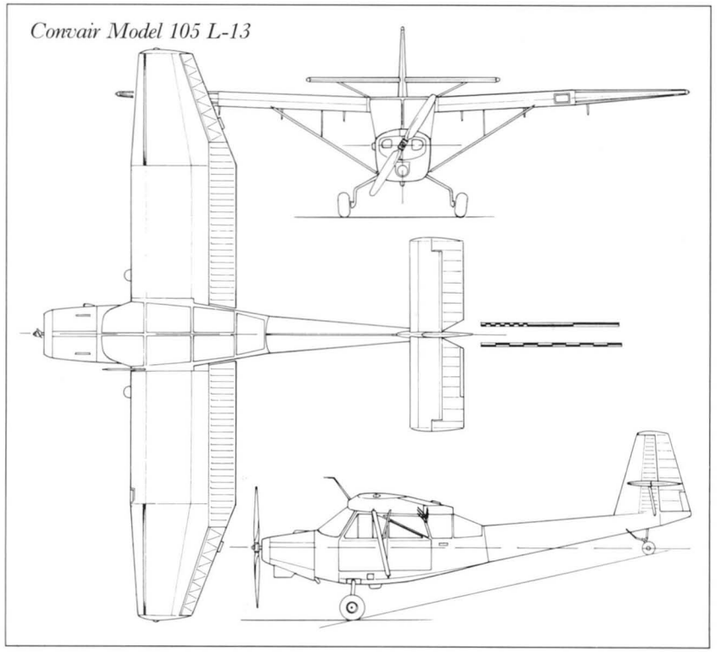
Two prototype XL-13s (45-58708/58709) were built at Wayne, Michigan, and flight tests resulted in an order for 300 L-13As (46-68/213, 47-267/420) built by Convair at San Diego with the 250hp O-425-9. Forty-eight went directly to ANG units. Following tests with 46-73, twenty-eight aircraft (46-110/111, 47-395/420) were converted to L-13B standard for Arctic use with the installation of a special combustion heater and ducting.

In the mid-1950s, surviving USAF aircraft were disposed of as surplus. A restricted certificate (AR-10) was issued to Lester Branchflower, Burbank, California, for stock L-13As, but as this category limited sales several conversions were undertaken. The Longren Aircraft Co, Torrance, California, converted one L-13A (msn 200/N4901V) as a six-seat bush aircraft in the standard licensing category called the Centaur 101 in 1958 with additional fin area and a 300hp Lycoming R-680-E3. The actual modification was undertaken by C Roger Keeney's ACME Aircraft, also at Torrance, who also fabricated a few Centaurs. Subsequently, the Centaur 102 was also produced with a Jacobs R-755-A2 engine.

The first Convair-production L-13A (46-068). (Convair)

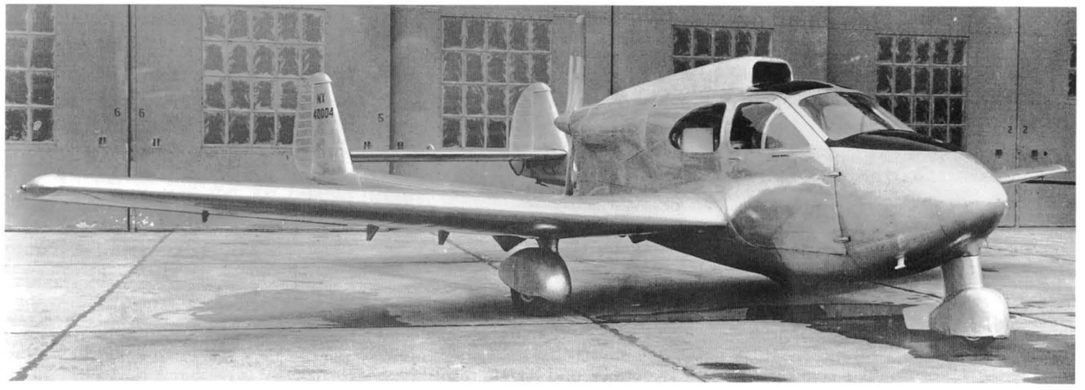
Caribbean Traders Inc in Miami converted a number as Husky Is (O-425-9), Husky IIs (300hp Lycoming R-680-13), and Husky IIIs (450hp Pratt & Whitney R-975-7). All models except the Mark I featured a swinging engine mount and quick-disconnect firewall fittings for easy maintenance and a constant-speed Hamilton Standard metal propeller replaced the original airscrew. Husky IIs were used by at least two airlines, Compañia Dominicana de Aviación (HI-28 and HI-31) and SATGA – Société Aérienne de Transports Guyanna-Antilles (F-OGAS) based at Cayenne, French Guiana. The latter flew to Martinique, Guadeloupe and other islands in the Lesser Antilles chain, and into a 300ft strip in French Guiana to supply a mining operation (a 20-minute flight over a one-week journey by boat, horse, and foot). Other Husky IIs were sold in Mexico and Bolivia.

A third modification, to be known as the CV-105, involved the installation of a Pratt & Whitney R-985. However, this was not approved. Today, approximately twenty-five L-13s



ACME Centaur 101 N65898 (msn 6 ex-47-302) was built in 1967 and was still active twelve years later at its home at Torrance, California. (John Wegg)

The Model 106 Skycoach was an abortive attempt to produce an 'everyman's aircraft'. (Stephen J Hudek collection)



The XB-46 with serial curiously displayed on fin as '5.59582'. (Convair)

remain on the US register and six are in museums.

L-13A

One 250hp Franklin 0-425-5 flat-six air-cooled engine.

Span 40ft 5½ in; length 31ft 9in; height 8ft 5in; wing area 270sq ft.

Weight empty 2,070lb; gross weight 3,185lb.

Maximum speed 115mph; cruising speed 92mph; climb 830ft/min; service ceiling 15,000ft; range 368 miles (60US gal fuel capacity).

Husky II

One 300hp Lycoming R-680-13 nine-cylinder air-cooled radial engine.

Dimensions as L-13A

Weight empty 2,045lb.

Cruising speed 121mph; range 700 miles with optional fuel tank; 255ft take-off at sea level at 2,650lb; landing distance 75ft.

Model 106 Skycoach

Another in the series of postwar light aircraft experimental designs, the sole Model 106 (NX40004 msn 1) was built by the Stinson Division and first flown in April 1946. Of all-metal construction, the four-seat Skycoach featured a non-retractable nosewheel undercarriage, twin booms and a 230hp Franklin 6A8-225-B8 engine driving a cooling fan and a pusher propeller. Bill Martin ferried the Skycoach to San Diego and most of the test flying was done there, with Bill Chana as flight test engineer. Performance was poor, with a maximum speed of 142mph (as compared to the Beech Bonanza that achieved 165mph on 165hp), and development was abandoned.

Model 109 XB-46

The Model 109 was Laddon's team's answer to a USAAF specification issued in April 1944 for a high performance all-jet bomber possessing a 1,000 miles tactical radius, a 500mph maximum speed, and a 40,000ft ceiling. The proposal submitted on 6 November, outlined a conventional design with a 113ft span Davis-wing shoulder-mounted on an equally slim fuselage of 105ft which contained the bomb bay and fuel cells. Four 4,000lb st General Electric TG-180 axial-flow turbojets were paired in two wing pod nacelles. The three crew were housed in a pressurised compartment, the two pilots under a fighter-type canopy, and the bombardier in the forward compartment with a glazed nose section. Normal bomb load was 8,000lb and defensive armament consisted of two 0.50in guns in a remotely-controlled tail turret.

Three prototypes (45-59582/59584), designated XB-46, were ordered on 27 February, 1945, and four other manufacturers also were awarded prototype contracts, North American for its NA-130 (XB-45), and Boeing, Martin, and Northrop for their XB-47, XB-48, and XB-49 respectively. In August, most of Convair's projects were cancelled, but work continued on the XB-46 at a slower pace although funds for two aircraft were diverted to the XA-44/XB-53 project. However, Boeing revised its XB-47 design into a swept-wing six-jet concept and it was obvious, barring a design error, that it would outperform the other designs with ease.

The sole XB-46 (45-59582), devoid of military equipment, was thus already outclassed when it first flew on 2 April, 1947, flown by E D 'Sam' Shannon, with Bill Martin as co-pilot. Despite almost perfect streamlining, its top speed of 545 mph was below that of the B-45.

The XB-46 was claimed to be the first US aircraft with a complete pneumatic system for the actuation of the undercarriage, bomb bay and crew doors, and brakes. Another unusual feature was that to permit almost full-span Fowler-type flaps, roll control was achieved primarily by 20ft long spoilers, the ailerons being just 6ft in length. There were few problems during flight testing at Muroc with Phase I (company flight tests) completed by September after 14 flights and 23 hours. The major change was to substitute Allison J35-A-3 engines and the XB-46 was then flown to Wright Field. Phil Prophett later became project test pilot and the USAF assigned Capt Glen Edwards to the XB-46, who was subsequently killed testing the Northrop YB-49 and gave his name to the Muroc base.

Following the completion of trials, the elegant XB-46 was flown to Eglin, Florida, and after various tests, was scrapped in mid-1950. A photographic-reconnaissance role was discussed for the B-46 but never implemented.

Four 4,000lb st Allison-built General Electric J35-A-3 axial-flow turbojets

Span 113ft 0in; length 105ft 9in; height 27ft 11in; wing area 1,285sq ft.

Weight empty 48,018lb; gross weight 91,000lb, maximum gross weight 95,600lb.

Maximum speed 545mph at 15,000ft; 491mph at sea level; cruising speed 439mph at 35,000ft; climb 35,000ft/19min; service ceiling 40,000ft; range 2,870 miles with 8,000lb bomb load (6,682US gal maximum fuel capacity).

Model 110

During early 1945, Convair started work on an all-metal 30-seat twin-engined airliner to cater for the expected postwar commercial transport boom and to upgrade the equipment of airlines operating the Douglas DC-3. In particular, American Airlines had issued a specification for a DC-3 replacement. Unpressurised, the Model 110 had engine nacelles which incorporated 'aspirated cooling', routeing exhausted cylinder air into the section where exhaust gases were also discharged. The mixture was then ejected via a tail-pipe forming the rear of the nacelle. Exchangers were used to provide cabin heating and leading-edge anti-icing. The bulky nacelles were mounted high on the low wing and accommodated the retracted mainwheels. Four-blade 12ft 2in Hamilton Standard propellers were fitted.

The rear fuselage featured integral ventral stairs to facilitate passenger boarding. Also innovative was the side passenger door located forward of the wing, instead of to the rear. Seven main porthole-type windows were installed in the 117in diameter fuselage although a full airline interior was not fitted.

By the time the sole prototype (NX90653 msn 1) was first flown on 8 July, 1946, from San Diego, piloted by Russell R Rogers and Art Bussy, market research had indicated that the airlines wanted a larger, pressurised 40-seat aircraft and a new design was already well in hand. Therefore, the Convair-110 (as the aircraft was marked) was used for development flying for the Model 240 Convair-Liner, then scrapped in September 1947. Test pilot Sam Shannon reported that the Model 110 was the best aircraft he ever flew, featuring a control response superior to the production Convair-Liners.

The tricycle undercarriage Model 110 was fitted with a tail 'bumper' wheel which can be seen in this photograph taken over southern California. (Convair)

Two 2,100hp Pratt & Whitney Double Wasp R-2800-SC13G eighteen-cylinder air-cooled radial engines.

Span 89ft 0in; length 71ft 0in; height 25ft 2½in, wing area 813sq ft.

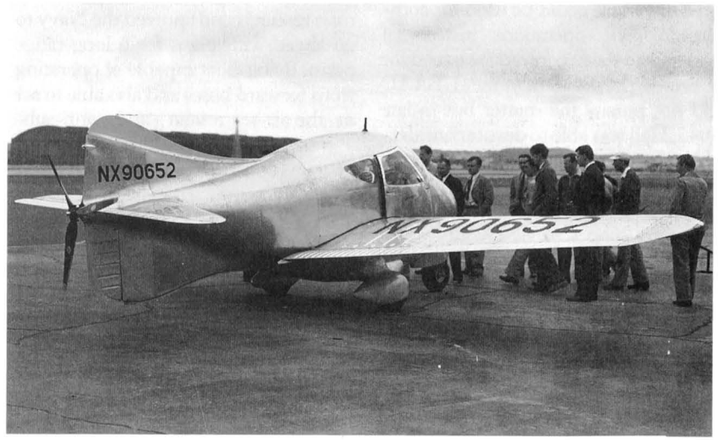
Weight empty 21,100lb; gross weight 35,970lb.

Maximum speed 314mph; cruising speed 260mph at 16,000ft; range 560 miles.

Model 111 Air-Car

In an attempt to produce an updated version of his prewar biplane Aircar, Joe Gwinn persuaded I M Laddon, now general manager at San Diego, to produce his new design. The sole Model 111 Air-Car (NX90652 msn 1) was built in mid-1945 at San Diego. A two-seat, side-by-side all-metal pusher monoplane with non-retractable nosewheel undercarriage, the rotund lines of the Air-Car quickly earned it the name of 'Pregnant Guppy'. The 65hp Continental four-cylinder engine, situated under the seat of the pilot and passenger, was cooled via small air intakes beneath the fuselage. Full-span flaps were fitted, but a rudder or directional

Few hours were flown with the Gwinn-inspired Model 111. (Convair)



The rear section of the Hall-designed Model 116 painted to resemble a family automobile. (San Diego Aerospace Museum)

control surface was only installed on the ventral fin. Taxi-ing tests were conducted in spring 1946 by Sam Shannon who made the first flight. Initial testing revealed that the rudder was inadequate and at certain speeds the aircraft had a tendency to lurch sideways. Wind-tunnel testing showed that the airflow was breaking down over the curved fuselage because of the direction of rotation of the pusher propeller. However, the project was not abandoned until the small diameter driveshaft between the engine and the propeller broke.

Model 116

Theodore Hall, Consolidated Vultee's chief development engineer, was fascinated with the concept of an 'air car' and had studied the problem before the war. In 1941, Consolidated had suggested to Wright Field that this type of vehicle could be used for commando style operations instead of gliders and that a contract be issued for a prototype. Evidently the USAAC did not pursue the matter but in late 1945, Hall was able to devote considerable energy to the idea of an 'aircraft in everyone's garage'. Hall's design featured a two-seat car body with a rear-mounted 26hp Crosley engine with a detachable flight section. The latter consisted of wings, a 90hp Franklin 4A4 engine durving a two-blade wooden propeller, and a tail unit. Completed in late June 1946, the prototype (NX90654 msn 1) was first flown on 12 July by Russell R Rogers with flight-test engineer Lawrence G Phillips. From the third flight, Bill Martin replaced Rogers as test pilot and in August, the 95hp Franklin 4AL-225 engine was substituted. A total of sixty-six flights was made up to December, 1946, and development continued with the Convair 118.

Weight emtpy (car) 573lb; (flight section) 500lb.

Maximum speed 112.5 mph at sea level.

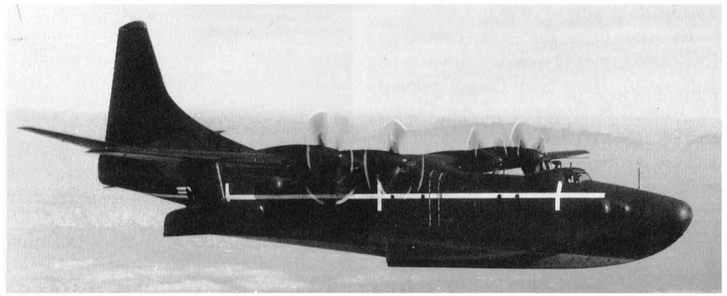
Model 117 P5Y and Model 3 R3Y Tradewind

During the latter part of the Second World War, considerable work was undertaken by Convair's Hydrodynamic Research Laboratory, led by Ernest G Stout, into advanced flying-boat hulls with high length-to-beam ratios that promised many improvements over existing designs. Confirmation of these bright prospects came with the examination of captured German research and spurred the Navy to go ahead with plans for a long-range patrol flying-boat capable of operating from forward bases and also able to act in the air-sea rescue and anti-submarine warfare (ASW) roles. Manufacturers were invited to submit proposals on 27 December, 1945, with the designs to include the latest hydrodynamic research and to be powered by propeller-turbines.

Convair's Model 117 was chosen and two prototype XP5Y-1s (BuA 121455/121456) were ordered on 19 June, 1946, with flight tests scheduled to begin in mid-1948. Originally, Convair's team, headed by Herbert Sharp, designed the sleek new 'boat, with a length-to-beam ratio of 10:1 (double that of the PBY), around the projected Westinghouse 25D (T30) propeller-turbine. However, industrial disputes at Westinghouse caused this engine to fall far behind in schedule and instead, the Navy chose the 5,100shp Allison XT40-A-4. A complex engine, the T40 consisted of two T38s coupled to a reduction gear via dual extension shafts and driving six-blade 15ft diameter contra-rotating propellers. Inevitably, development delays occurred which caused further engine delays and the two prototypes were rolled out engineless at San Diego in mid-1949.

Apart from its massive size, the XP5Y-1 was a conventional aircraft with a cantilever high-wing, fixed floats on the wings, and a single tail unit adapted from that used on the XB-46. Convair also forsaw a possible transport application and accordingly, in order to alleviate the need for watertight bulkheads, incorporated a multicellular construction technique for the hull. For its originally intended role, the proposed armament was ten 20mm cannon in five remotely-controlled barbettes (one one each side of the nose,

Model 117 XP5Y-1 (BuA 121455) in dark blue Navy colours with white stripes for flight test camera reference. (Convair)



Model 3 R3Y-1 Tradewind BuA 128446 of VR-2 off the coast at Honolulu, Hawaii. This aircraft was destroyed on 24 January, 1958, at NAS Alameda, California. (US Navy)

one each side of the aft fuselage, and one in the tail). With a gross weight of 123,500lb, a bomb load of 8,000lb could be carried and extensive armour for the crew included. However, by early 1949, the primary mission of the P5Y-1 had been changed to ASW and, still later, to mine-laying without any defensive armament. Thus, the turrets of the prototypes were faired over.

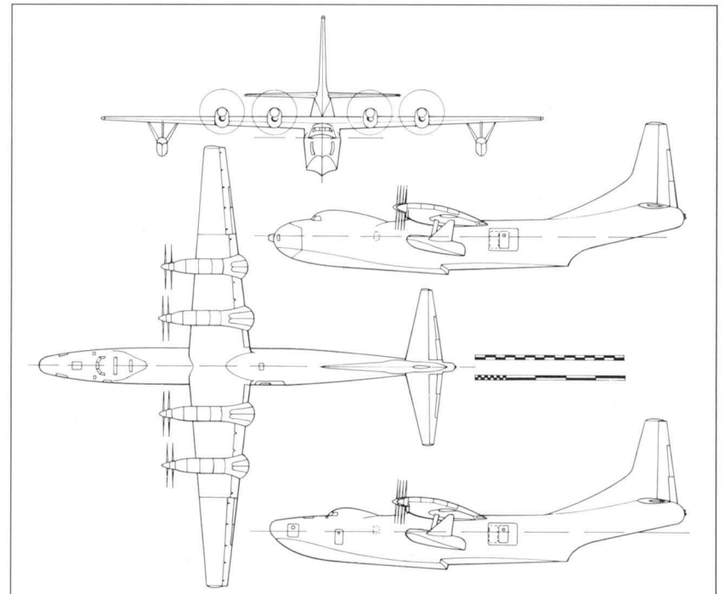
Engines were finally ready for installation in the first prototype by the end of 1949, but none had yet achieved a satisfactory 50-hour test. Nevertheless, extensive taxiing tests were conducted from January and the first flight, lasting just 29 minutes, was made with airframe and engine on 18 April, 1950, by Sam Shannon. Despite endless troubles with the T40, the XP5Y-1 managed to establish an endurance record in early August for propeller-turbine-powered aircraft with a flight of 8hr 6min.

However, the same month, the Navy announced it would discontinue further development of an ASW version in favour of the aircraft as a pure transport. The XP5Y-1 continued flight tests of the XT40-A-4 until 15 July, 1953, when it suffered loss of elevator control during a high speed test dive. Longitudinal trim was used to recover, but the aircraft entered an uncontrollable divergent phugoid (porpoise) forcing abandonment by project pilot Don Germeraad and his 10-man crew just before its plunging into the ocean off Point Loma, San Diego. The unflown second XP5Y-1, used only for beaching tests and other ground trials, was broken up in 1957.

On 16 August, 1950, a contract was placed for six (BuA 128445/128450) Convair Model 3s, designated R3Y-1 Tradewind, with short-shaft 5,332 shp T40-A-10s in more forward-mounted nacelles. There were other substantial changes in this transport version. The hull was lengthened by 14ft 7in with a 10ft cargo hatch in the port side aft of the wing, a pressurised 9ft wide cabin accommodated eighty passengers or seventy-two stretchers with eight medical attendants, the barbettes were discarded and round windows installed, and a taller tail introduced. The first flight was made on 25 February, 1954, almost a year behind schedule. A year later, one (BuA 128448) flew from San Diego to Patuxent River, Maryland, in the record time of six hours at an average speed of 403mph, a world record for seaplanes that has never been broken.

By this time, an assault transport version of the Tradewind, the R3Y-2, had already flown. This variant featured a raised flightdeck with a shorter bow incorporating power-operated ramps and an upward-opening loading door. Up to four 155mm howitzers, six jeeps, three $2^1/_2$ ton trucks, or two half-track vehicles could be discharged onto landing beach. The first aircraft (BuA 128450) was taken from the R3Y-1 order and first flew on 22 October, 1954. Five others (BuA 131720/ 131724) were completed.

Three R3Y-2s and one R3Y-1 were



Convair Model 3 R3Y-1 Tradewind with R3Y-2 side view

converted for the tanker role with a four-point hose system with fuel taken from the wing tanks. Tests with Grumman F9F Cougars from VF-111 in September 1956 were the first simultaneous refuelling of four receiver aircraft by any air tanker. A severe problem with turbulence was resolved by extending the inboard hoses further than the outer two, but use of the aircraft was in any case limited.

Seven R3Ys were delivered to VR-2 at NAS Alameda, California, between March and November 1956, to replace the Martin Mars on trans-Pacific services. On 18 October, a new seaplane record of 6hr 45min was established between Honolulu and NAS Alameda (at 360mph) but the new type continued to suffer from engine problems and only a dozen or so flights were made to NAS Honolulu. On 10 May, 1957, the *Coral Sea Tradewind*, the aircraft that had made the record-breaking run two years earlier, was written off in San Francisco Bay in a heavy alighting following loss of control after a propeller ran away. Then, on 24 January, 1958, the *Indian Ocean Tradewind* (all VR-2's aircraft were named) lost a complete gearbox while on a return flight to Alameda from Hawaii. A successful alighting was made, but asymmetric power problems caused the R3Y-2 to hit a seawall.

There were no fatalities in either incident, but the Navy prudently grounded all Tradewinds immediately. Although it was proposed that the Tradewind participate in the atomic-powered aircraft development programme, and be re-engined with Rolls-Royce engines, no further flying took place and the remaining aircraft were scrapped.

XP5Y-1

Four 5,100shp Allison XT40-A-4 propeller-turbines.

Span 145ft 9$^{7}/_{8}$in; length 127ft 11in, height 46ft 2in, wing area 2,102sq ft.

Weight empty 71,824lb; gross weight 140,374lb, (normal 123,500lb).

Maximum speed 388mph at 30,000ft; cruising speed 225mph; climb 3,310ft/min; service ceiling 39,700ft; range 2,785 miles (with eight 325lb depth charges); ferry range 3,450 miles.

R3Y-2

Four 5,332shp Allison T40-A-10 propeller-turbines.

Length 139ft 8$^{3}/_{8}$in, height 51ft 5in.

Gross weight 145,500lb, maximum gross weight 165,000lb.

The Model 118 flying just north of San Diego. (Convair)

Model 118

Following the trials with the Model 116 in 1946, Hall developed the air car concept with a more sophisticated version, powered by a 190hp Lycoming O-435C and a three-blade Sensenich propeller. First flown on 15 November, 1947, by Reuben P Snodgrass and Phillips, the prototype (NX90850 msn 1) ran out of fuel on the approach to San Diego-Lindbergh Field three days later and made a forced landing at nearby Chula Vista. Although the flight section was undamaged, the car body was completely destroyed and Phillips injured. A second combination (still registered NX90850 but now msn 2) was flown on 29 January, 1948, by Bill Martin with W G Griswold, using another car body, the fifth in this series of tests, and the flight section from the first 'aircraft'.

Another view of the Model 118 flying just north of San Diego. (San Diego Aerospace Museum)

Optimistic plans were drawn up for mass production of the air car and military and more powerful versions projected with 40ft span wings. However, the combination craft was subject to tail shake and weight problems and with high costs and limited interest, the programme was terminated. Hall left Convair to attempt to develop his interest independently.

Span 34ft; height 8ft 4in.

Weight empty 1,524lb; gross weight 2,550lb.

Demonstration of the attachment of the flight section of the Model 118 to the car body at San Diego. (Convair)

YB-60

A swept-wing configuration for the B-36 was proposed in 1950, initially with propeller-turbines then with eight 8,700lb st XJ57-P-3 turbojets paired in underwing pods, as on the B-52. This version was designated B-36G, but by the time two prototypes were ordered on 15 March, 1951, from the B-36F production line, the designation had been revised to YB-60. The 35 degrees swept-back wing reduced the wing span by 24ft but the wider centre chord increased the wing area to 5,239sq ft. All except the twin 20mm tail guns were removed and a pointed nose cap ended in an instrument probe. The tail shape was streamlined and heightened by 2ft. Bomb capacity remained unchanged and the five crew were housed in a similar pressurised compartment to that of the B-36F.

With 72 per cent parts commonality with the B-36, the first YB-60 (49-2676) was completed in eight months, and with Beryl A Erikson as pilot, made its first flight at Fort Worth on 18 April, 1952, three days after the YB-52. Flight tests at Edwards AFB revealed that the YB-60 was over 100mph slower than the B-52 and thus plans for the B-60 to replace the B-36 on the line at Fort Worth were shelved.

Only about 40 hours were flown by the first YB-60 and the USAF never delivered engines for the second (49-2684). Although officially handed over to the USAF in mid-1954, both were already cocooned and they were scrapped soon afterwards. A commercial transport version was not proceeded with.

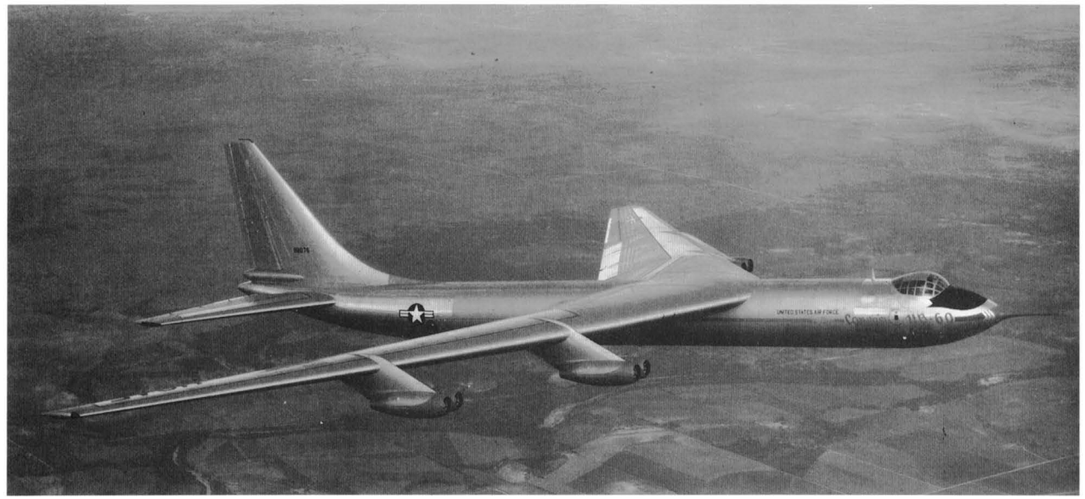
Eight Pratt & Whitney 8,700lb st J57-P-3 turbojets.

Span 206ft 0in; length 171ft 0in; height 50ft 0in; wing area 5,239sq ft.

Weight empty 153,016lb; gross weight (estimated) 300,000lb.

Maximum speed 508mph at 39,250ft; ceiling 44,650ft; combat radius 2,920 miles with 10,000lb load; ferry range 6,192 miles (38,500US gal fuel capacity).

Only one (49-2676) of two YB-60s was flown. (Convair)



Model 240 Convair-Liner Series

Even before the Model 110 had made its first flight, discussions with various airlines, and in particular American Airlines, indicated that an improved 40-seat medium-range transport was desirable. Therefore, in late 1945, Convair launched the 240 (two engines, forty passengers) with an order for 100 aircraft from American Airlines. Additional contracts for over fifty more were signed with Western Air Lines, Pan

Although painted in FAMA colours, Convair 240-6 LV-ADP (msn 72) was delivered to Aerolineas Argentinas in September 1949. (W Balogh)

Western Air Lines Convair 240-1s N8405H and '09H at Oakland, California. (John Wegg collection)

American Airways, Continental Airlines, KLM, and Trans-Australia Airlines.

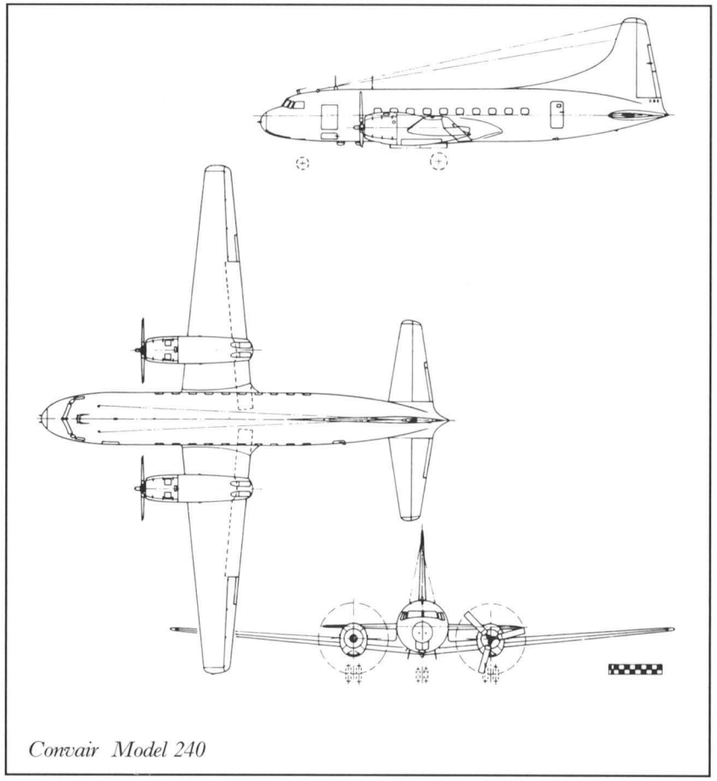
Of conventional all-metal construction, except for a fibreglass rudder and elevator trailing edges, the 240 had a multi-spar wing with hydraulically-operated Fowler-type flaps. Fuel was contained in two 500US gal capacity tanks outboard of the two nacelles housing Pratt & Whitney Double Wasp R-2800 engines driving three-blade Hamilton Standard or Curtiss reversible-pitch propellers. An exhaust augmented cooling system was incorporated, as it was on the Model 110, and although this provided some additional thrust, the benefits were offset by the high cabin noise level. Wing and tail de-icing was effected by heat exchangers and 'orange peel' cowlings were adopted for ease of maintenance. The retractable nosewheel undercarriage featured twin-wheels on both main and nose legs.

The pressurised fuselage, the first for a twin-engined transport, accommodated forty seats in a comfortable ten-row four-abreast layout with an 18in aisle despite a diameter of 113in, four less than the Model 110. Two pilot operation was normal, but some foreign customers also specified a radio operator. Customers could choose from four basic interior and door arrangements. Type A featured a starboard front passenger door, ventral air stairs, starboard rear cargo door and port rear service door; Type B ventral air stairs, starboard front service door and auxiliary port rear door; Type C a port rear passenger door, starboard front service door and rear cargo door; and Type D a port rear passenger door with starboard rear cargo door and port front service door. These were also referred to as Type A, W, P, and S respectively after the initial customer for each, American, Western, Pan American, and Swissair. Subsequently, there were modifications to individual aircraft. All had a rear starboard side toilet but galley and carry-on baggage space varied.

The 240 prototype (N90849) was first flown on 16 March, 1947, from San Diego by Sam Shannon and Russell R Rogers with flight engineers L J Bordelan and J T Ready. Following a 16-week flight-test programme, the 240 was approved for a gross weight of 40,500lb with R-2800s rated at 2,300hp for take-off. Deliveries to American (Model 240-0) started on 23 February, 1948 (NC94211 msn 20) and following the award of Type Certificate 793, entered service with the airline on 1 June. In Europe, KLM was the first operator closely followed, in Australia, by Trans-Australia Airlines on 18 October. The following January, the 100th aircraft (a 240-4 for KLM) was rolled out. Because of the various configurations for each customer, dash numbers were applied to distinguish customers. In 1950, gross weight was increased to 41,790lb and fuel capacity to 1,550US gal with the addition of outer wing tanks, and the first deliveries to this standard were made to Ethiopian Airlines and Garuda Indonesian Airways. Ethiopian was also the first airline to use JATO units, as a precaution at 'hot and high' airports on its African routes. The 240 fleet completed 840,000 hours before its first fatal accident (an American Airlines' aircraft at Elizabeth, New Jersey, on 22 January, 1952) which was, by far, the best safety record of any transport up to then.

Airline orders finally totalled 171 with deliveries also made to Aerolineas Argentinas (FAMA), Civil Air Transport Corp (China), Northeast Airlines, Orient Airways (which operated the first Asian services on 1 May, 1949), and SABENA. Including the prototype, five were retained for testing or sold to corporate owners (including one in Mexico) and the remainder of the 566 built were delivered to the USAF in the following versions.

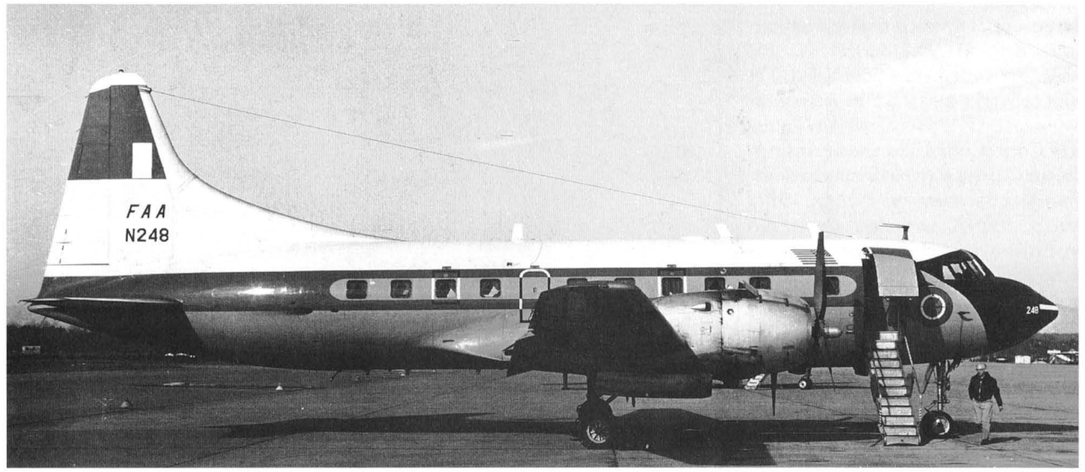
T-29A-CO Flying Classroom: Model 240-17, navigation and bombardier trainer to replace B-25Js with accommodation for fourteen students, four astrodomes, belly radar, eighteen antennae, 2,400hp (wet) R0-2800-77s, and gross weight 40,500lb. Because of procurement competition rules, the T-29As were unpressurised (probably to allow the Martin 2-0-2 to compete). A prototype initially designated XAT-29, later XT-29 (49-1910 msn 169) was first flown on 22 September, 1949. A second prototype (49-1913 msn 152) was followed by forty-six production aircraft (49-1911/1912, 49-1914/1945, 50-183/194) delivered from 8 March, 1950, to October 1951. The final batch had R-2800-97s which were later installed in the earlier aircraft. The initial two aircraft were later converted to full T-29A standard and in 1951, all received bombardier training systems, outer wing tanks to increase fuel capacity by 500US gal to 1,500US gal, and gross weight of 43,575lb.



Convair Model 240

At least four (49-1910/1912/1917/1933) were converted at Fort Worth in 1958 to pure cargo configuration as CT-29As, one (49-1934) became a

Pre-delivery photograph of T-29C (Model 240-27) 53-3475. (Convair)



ET-29C (240-27) N248 of the FAA. Note right-hand forward entry door. (John Wegg collection)

GT-29A after relegated to a ground instructional airframe, one for electronic systems testing as an NT-29A, and twenty-six were converted as 23-seat staff transports as VT-29As.

T-29B-CO: Model 240-27 similar to -17 but with pressurisation, one less astrodome and R-2800-97 engines; 105 (51-3797/3816, 51-5114/5172, 51-7892/7917 msn 225/329) built; first flown 12 December, 1951, with deliveries from 30 April, 1952, until 19 August, 1953. A baleout door was added from 51-5159 onwards and four were converted to VT-29B staff transports at Burbank before delivery. Two (51-5127/5133) were Type Is for thirty-two passengers and two (51-5115/5119) were Type IIs for twenty-seven passengers. Convair modified two (51-3811/5132) in 1959 as NT-29Bs for use by the Eglin Gulf Test Range with additional electronics, twin Mars APUs, and seven antennae housed in four fuselage blisters (three dorsal, one ventral). A further sixty were converted to 23/32-seat VT-29Bs and one (51-7913) became an NVT-29B when fitted with a starboard cargo door and used as an airborne laboratory. Ten were loaned to the Navy in 1963 and used at NAS Corpus Christi, Texas, by VT-29 to replace Douglas TC-117Ds.

T-29C-CO: Model 240-27 with 2,500hp (wet) R-2800-99W engines; 119 (52-1091/1175, 53-3461/3494 msn 330/448) built; first flown 28 July, 1953, with deliveries from 11 September, 1953, until 20 April, 1955. Wingtip Fairchild J44 turbojets were to have been fitted to twenty aircraft at the Air Force Academy, Colorado Springs, in 1957, but this conversion was not proceeded with. Ten were modified for airways aids checking as AT-29Cs for the FAA, redesignated ET-29Cs in 1962, and two subsequently became 23-seat VT-29Cs along with at least fourteen others. Three were loaned to the Navy in 1975 and used by VT-29 until November 1976.

T-29D-CO: Model 240-52, bombardier training version with completely revised interior with nine stations and astrodomes replaced with periscope sextants; ninety-two (52-1176/1185, 52-5812/5836, 52-9976/9980, 53-3495/3546 msn 52-1/92) built; first flown 11 August, 1953, with deliveries from 27 January, 1954, until 26 August, 1955. At least forty-six converted to 23-seat VT-29Ds and eleven as ET-29Ds to train ECM operators for the Douglas EB-66.

C-131A-CO Samaritan: Model 240-53 for casualty transport of twenty stretchers and seven seats (as MC-131A) or with thirty-nine aft-facing seats with port cargo door, R-2800-99W engines; twenty-six built (52-5781/5806 msn 53-1/26). First flown 5 March, 1954, with deliveries to MATS 1 April to 29 December, 1954, all redesignated C-131A in 1962 and some flew as VC-131A. Five more (52-5807/5811) were cancelled. In October 1976, twenty-four were transferred to the Coast Guard and modified by Hayes Aircraft, Birmingham, Alabama, as HC-131As for SAR duties pending delivery of Dassault HU-25A Guardians.

Additionally, one YT-32 (Model 240-18, 49-1946) was ordered on 28 October, 1948 (with the first batch of T-29As) as a pressurised bombardier trainer with a transparent nose and raised cockpit above the roof line. This was cancelled on 13 January, 1949.

With the withdrawal of the 240 from the fleets of the initial airline customers, the aircraft passed to the second-hand airline market and corporate customers. In the mid-1970s, when the USAF started to dispose of its 390 aircraft, a large number were converted for civil cargo use and today there are few 240s in passenger service.

The last fifteen 240s proved difficult to sell and Convair had considered terminating the whole project. However, the sale of the pressurised Martin 4-0-4 to Eastern Air Lines and Trans World Airlines prompted Convair to refine its basic design. Originally designated 240-A, then 340, the new model was announced on 28 November, 1950, with a fuselage lengthened by 54in to allow an extra four-seat row in the cabin. To improve high altitude airport operation capability, the wing span was increased from 91ft 9in to 105ft 4in which also allowed an additional 750US gal fuel capacity, and the flaps divided into two sections. More powerful R-2800-CB16/17 engines were installed in 7in longer nacelles, and propellers were standardised on the Hamilton Standard with a 4in increase in diameter to allow interchangeability with those of the DC-6.

Longer undercarriage legs and larger tyres increased the height slightly. There were also modifications to the pressurisation system and all passenger doors and integral stairs were positioned on the port side to be compatible with ramp docking facilities. As many of these improvements were made to satisfy United Air Lines, this airline became the launch customer with an initial order for thirty.

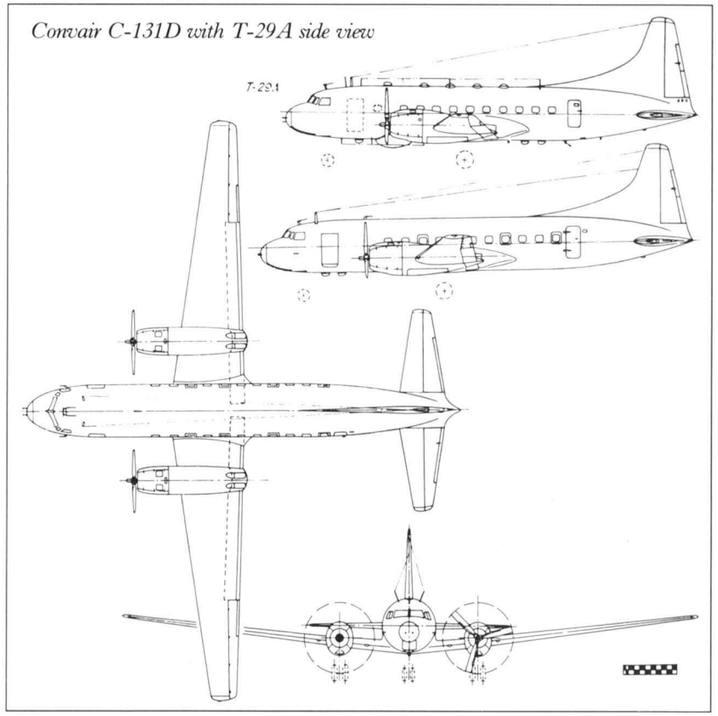
The prototype Model-340 (N3401 msn 1) made its first flight on 5 October, 1951, in the hands of Sam Shannon. Based on a T-29A airframe, this was the only 340 with a starboard side passenger door and was restricted to a gross weight of 46,725lb. In contrast, production 340s were certificated at 47,000lb under amended TC 6A6 issued on 27 March, 1952. The first delivery was made to United four days later and the type entered service on 16 November.

Other initial airline deliveries were made to Aeronaves de México, Alitalia, Ansett, AVENSA, Braniff Airways, Continental Airlines, Cruzeiro do Sul, Delta Air Lines, Finnair, Garuda Indonesian, Hawaiian Airlines, JAT, KLM, National Airlines, Pan American Airways (intended for Mexicana and after storage, passed to LACSA and National Airlines), Philippine Air Lines, and Saudi Arabian Airlines. Twelve went to corporate customers to make a total of 209 civil aircraft. A further 102 (for a total of 311) were built for the USAF and Navy as follows.

C-131B-CO: Model 340-70 (originally intended as 240 airframes) for airborne electronics test-bed or forty-eight seats in transport role, R-2800-103Ws, fuel capacity 1,730US gal and gross weight 47,000lb; thirty-six built (53-7788/7823 msn 240/275). First flown 1 December, 1954, and delivered from 28 December, 1954, until 28 September, 1955. One (53-7823) fitted with two detachable Solar T-41 APUs below inner wings in 1955 at the Wright Air Development Center in connection with zero g test flights. Six aircraft modified for missile tracking were designated JC-131Bs and operated by the 6560 Operations Group (Range Support) and one other (53-7797) became an NC-131B. Another (53-7822/ NAFEC-2) was used by the FAA in 1960 at the National Aviation Facilities Experimental Center, Atlantic City, New Jersey, to make the first arrested landings by a transport aircraft fitted with a belly hook (designed by All American Engineering Co) which brought the aircraft to a standstill in 4,050ft. A few were modified as VC-131Bs.

Europe-based USAF C-131A-CO (Model 240-53) 52-5787 landing at RAF Mildenhall. (George Pennick)

YC-131C-CO: One Model 340-36 (53-7886 msn 91 ex-N5511K) and one Model 340-64 (53-7887 msn 131) were assigned for conversion at Fort Worth to test the 3,250shp Allison YT56-A-3 propeller-turbine with three-blade Aeroproducts propellers. The first made its initial flight on 20 May, 1954, and the second on 29 June, then both were operated by the 1700th Test Squadron at Kelly AFB for 3,018 hours up to 17 December, 1955. One (53-7886) was subsequently re-engined with the 501-D13 and used by PacAero for some of the early 580 development testing. Then it was purchased by Tex Sun Beech who applied for and received an STC, with the unofficial designation Model 770, in



The sole R4Y-1Z (340-66), assigned to NAS Anacostia. (John Wegg collection)

order to offer the military conversions of the T-56 to a configuration almost the same as the 501-D13. However, no orders were received and no other conversions were undertaken. The designation C-131C had previously been reserved for sixty-one 340 airframes for SAC as support aircraft with a cargo door, cancelled on 10 March, 1953.

C-131D-CO: Model 340-79 for MATS Continental Division with 44 seats and R-2800-103W engines; ten built (54-2806/2807/2810/2813, 55-290/291/295/296/298/300) and first flown 28 July, 1954, with deliveries from 27 August, 1954, until 17 March, 1955. Six others were cancelled and replaced with Model 440-79s.

VC-131D-CO: Model 340-67 for staff transport, R-2800-103W; sixteen (54-2808/2809, 2811/2812, 2814/ 2825) with deliveries between 10 September, 1954, and 26 April, 1955. One similar Model 340-68 (54-2405) delivered 29 September, 1954.

R4Y-1: Model 340-71 with forty-four seats, port cargo door and strengthened floor, and R-2800-52Ws thirty-six (BuA 140993/141028 msn 276/311) delivered from 1 August, 1955, until 27 June, 1956. Most converted to 440 standard and redesignated C-131F in 1962. One (141024) was converted for ECM training as an EC-131G with the Pacific Missile Test Center, Pt Mugu, California, and others were modified to VC-131Fs.

R4Y-1Z: Model 340-66 VIP transport for 24 seats/6 berths, one (140378 msn 140) delivered 29 April, 1954, and assigned to NAS Anacostia.

In addition, the T-29E (Model 340-43/44/45) was ordered on 28 September, 1951, initially projected with Allison propeller-turbines in three interior versions, then the design changed to the Model 340-50 with YT38-As. The order was cancelled in October 1952 because of lack of funds. A 340 Convertible was announced in 1952 with an eleventh window on each side and seats on tracks to permit a maximum of fifty-six seats for night coach operations but none were completed. Two years later, a 340 Freighter was offered with a 6ft by 10ft rear fuselage door and a strengthened floor for a payload of 15,000lb but this version also remained a design study. Convair also considered a version with Wright Turbo-Compound R-3350 engines and seating for up to sixty-five passengers in an all-coach configuration.

In order to compete with the propeller-turbine Vickers Viscount, the Model 340B was announced in 1954 which soon after became known as the Model 440 Metropolitan. The major change was to a rectangular exhaust outlet instead of the twin tubes of earlier versions in an effort to reduce cabin noise. More streamlined cowlings were fitted, extra soundproofing was added and gross weight climbed to 49,100lb (later 49,700lb). Weather radar was offered as optional equipment, although most 440s were delivered thus-equipped with a radome that increased the length by 28in. Cabin accommodation remained at 44 seats although a 52-passenger interior was also offered with an extra window each side.

One 340 (N8431H msn 202) was retained by Convair to test these refinements and was first flown after modification, again by Shannon, on 6 October, 1955. The initial production 440 (msn 312) first flew on 16 December, certification was received on 30 January, 1956, and the first delivery made to Swiflite (Cities Service Oil). The first airline operator was Continental Airlines, which introduced the 440 on 8 March, 1956. Braniff, Delta, Eastern, Mohawk, and National also ordered 440s, but the majority of the airline aircraft went to overseas customers, most of which found the improved Convair-Liner sufficiently effective to be able to pass by the propeller-turbine stage entirely. The following military versions were completed to make a total of 199 aircraft and a final Convair-Liner total of 1,076.

C-131D-CO: Model 440-79, six (55-292/294, -297, -299, -301) similar to 340-79 for MATS.

C-131E-CO: Model 440-72 ECM trainer for SAC use with cargo door, R-2800-103Ws, became TC-131E; ten (55-4750/4759) delivered 19 July to 30 October, 1956, and one more (57-2552) on 27 November, 1957. Six became RC-131F for photographic survey and one a RC-131G for airways checking. Four others (57-2548/2551 to N101/ 104) were procured on behalf of the CAA (later FAA) for similar duties. At least five were modified as EC-131Es.

R4Y-2: Model 440-71 for research and transport; two (BuA 145962/ 145963) delivered in January 1958 and

The Model 440 Metropolitan enabled many airlines, including SABENA, to skip the propeller-turbine era completely. (John Wegg collection)

The Swedish domestic airline Linjeflyg operated a large fleet of Convair 440 Metropolitans for many years. (John Wegg)

redesignated C-131G in 1962; the second became a VC-131G. An additional thirteen were cancelled as were five R4Y-2Q ECM trainers, fourteen R4Y-2S ASW trainers, and six R4Y-2Ts (Model 440-91s).

Other military deliveries were made to Australia (two for No 34 Flight at Canberra), German Federal Republic (two for the Flugbereitschaftstaffel at Col-ogne), and Italy (one for the 306 Gruppo). Germany and Italy increased their military 440 fleets through second-hand purchases to six and four respectively. Other air forces that eventually acquired 440s were Bolivia, six used by Transporte Aéreo Militar (TAM) from 1972-1980; Spain, four ex-Iberia for Escuadron 911 at Madrid-Getafe and designated T.14; Paraguay, one C-131D (msn 321/T-93); and Sri Lanka, one (CR-811 msn 427).

Convair also supplied kits for operators to modify 340s to a standard close to the 440 and over one hundred were so converted.

The Model 440A was offered in 1954 as a convertible passenger /cargo aircraft but none were built. However, an STC (Supplemental Type Certificate) was later issued to Bob Lamson, a former Boeing test pilot, for the installation of a forward fuselage cargo door in the 340/440 series. Other 440 projects included studies with 1,000lb st wingtip auxiliary jet engines in 1955, actually offered to airlines two years later with either the Fairchild FT-101E (J54) or Continental 352-29 (also available for 340s). A more comprehensive redesign was the 60-passenger Model 15, a 15ft 10in stretched fuselage version with four 2,000eshp Rolls-Royce Dart R.Da.7 propeller-turbines announced in late 1955 and aimed at American Airlines.

From the very beginning of the

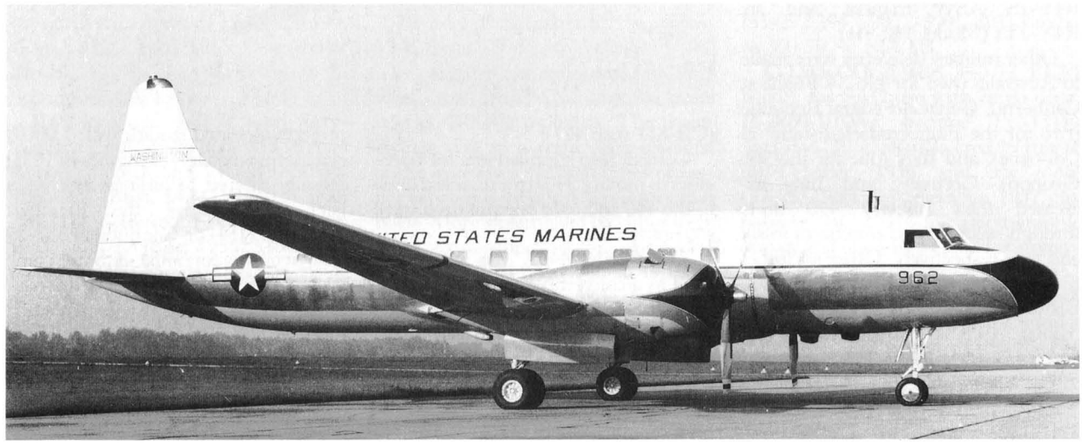
This US Navy C-131F (Model 340-71) assigned to Mildenhall, has been upgraded to 440 standard. (Peter Zastrow)

Convair-Liner programme, the airframe was designed to take propeller-turbines. The first conversion was made by the Allison Division of General Motors in co-operation with Convair. The prototype 240 (N24501 msn 1) was fitted with two 2,750eshp Allison 501-A4s (T38s) and, as the Model 240-21 Turbo-Liner and the first US propeller-turbine transport, made its first flight on 29 December, 1950, with R C Loomis and Donald P Germeraad. However, this engine was not developed enough for commercial applications and after a decade of use as an engine test-bed it was re-converted to Double Wasp power. A second conversion had been the YC-131C for USAF evaluation.

The first commercial propeller-turbine conversion was made from a 340 (msn 153/G-ANVP) by D Napier and Son Ltd at Luton in England in 1955. Fitted with 3,060eshp Napier Eland N.El.1s and four-blade de Havilland propellers, it was first flown on 4 February, 1956. A cruising speed of 315mph at 16,000ft was recorded and on 21October, 1957, the Napier Eland Convair Series 2 was awarded a certificate of airworthiness. The following month, the Eland Convair (re-registered N340EL) was delivered to PacAero Engineering Corp, Santa Monica, who had been designated by Napier to handle US certification with 3,412eshp N.El.6 Eland 504 engines. This proved more difficult than anticipated, and a Supplemental Type Certificate (STC) was not issued until 22 August, 1958, for the Napier Eland Convair 340/440 Mark I. A second aircraft, known as the Mark II, was converted from a 440 (N440EL msn 445) with US components and received its STC on 19 December, similarly with a gross weight of 53,200lb.

In 1957, REAL of Brazil ordered three Eland conversions but later cancelled them. Therefore, the first operator of the Convair 540 Cosmopolitan (as the type was publicised) was Allegheny Airlines, which leased the second aircraft for three months from 1 July, 1959, to become the first local service airline to fly a turbine-powered type. The Eland Convair was used on *Leilani* service (celebrating Hawaii's statehood) to Atlantic City, New Jersey, and resulted in an order for five which were converted by AiResearch. Allegheny also operated the two prototypes.

Recognising the potential market, all Convair-Liner jigs and tooling were transferred to Canadair Ltd, a General Dynamics-owned company, in anticipation of production of CL-66As, new 440 airframes with Eland engines. None of these were built, but Canadair did receive an order for ten CL-66Bs (equivalent to the 440-72 with Eland 504A) from the RCAF (11151/11160), designated CC-109 Cosmopolitan. The first flight was made on 7 January, 1960, and deliveries to No.412 Sqdn were made between July and March 1961. Before this, Canadair converted three unsold 440s to 540 standard (designated CL-66C) and the first flight was made by William Longhurst from Montreal on 2 February, 1959. One was retained as a company demonstrator and the other two were leased to Quebecair pending delivery of its own order. Quebecair started its Convair service on 24 August, 1960. The designations CL-66D and CL-66E covered a convertible passenger/ freight version of Canadair-built Allison-engined 440s but neither were completed. A further order for three was placed by Caribair

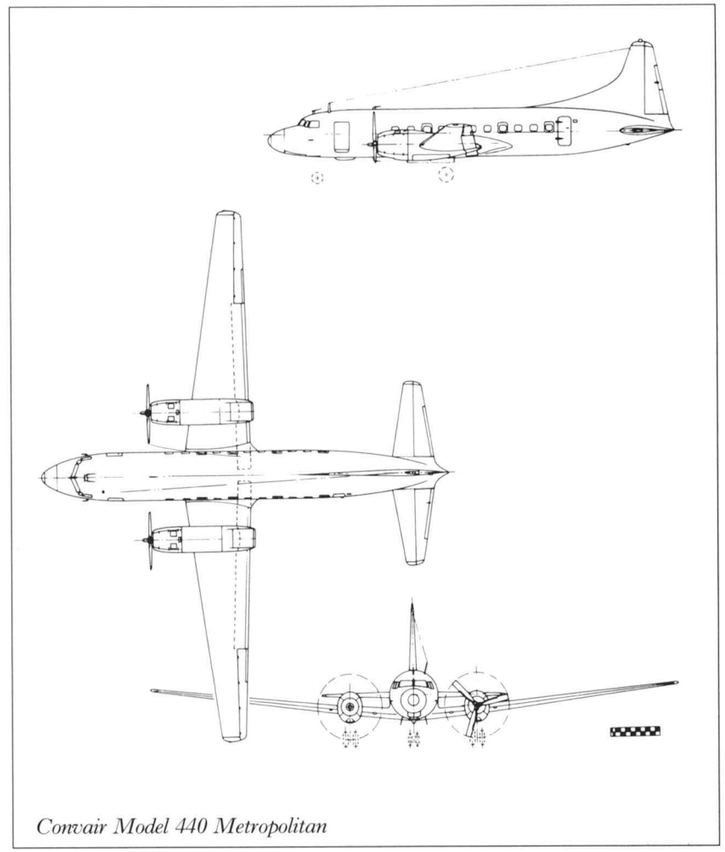


C-131G (Model 440-71) assigned to the Marine Corps, Washington, DC. (Larry Milberry)

but all work ceased with the takeover of Napier by Rolls Royce in 1962. All but the Canadair conversions, which were accepted by the RCAF, reverted to 340/440 configuration.

The most successful of the propeller-turbine conversions was the Allison 'Prop-Jet Super Convair', powered by 3,750eshp 501-D13 engines (civil version of the T56), which resulted in 170 aircraft being modified. In order to gain operating experience, Allison obtained a YC-131C (msn 91/53-7886) from the USAF on loan and installed 501-D13 engines. Testing under the name *Operation Hourglass* started on 1 November, 1957, and 1,000 hours were logged by 23 January, 1958. To counteract the effect of the more powerful engines, 340/440 conversions (240s were not considered structurally suitable) required a 12in taller tail and a 40in increase in tailplane span. Four-blade, 13ft 6in diameter square-tipped Aeroproducts propellers were fitted and additional soundproofing material installed along with a revised cockpit layout. Operating weights and performance were increased substantially and an optional modification was the increase of wing fuel tank capacity to a maximum of 2,908US gal. Modifications were also made to the exhaust ducts from those fitted to the YC-131C.

Because Convair was fully occupied with the 880 programme, Allison contracted conversion work to PacAero at Santa Barbara and the first aircraft (msn 33/N5100) was flown on 19 January, 1960. An STC was awarded on 21 April, 1960. All the early conversions, made at Burbank from October 1962, were completed for corporate customers and the initial delivery was made on 6 May, 1960, to General Motors. Hawaiian Airlines and Lake Central Airlines were the first airlines to order the conversions, but later cancelled them. Thus the first airline operator was Frontier Airlines which specified 501-D13H engines for high altitude operations and a 52-seat interior. Frontier also chose the name Convair 580 for marketing purposes,



Convair Model 440 Metropolitan

An Eland-powered Canadair CL-66B CC-109 Cosmopolitan of 412 Squadron, RCAF. (Larry Milberry)

Originally a 440-59, N21466 became a 580 then was converted by Jack Conroy's Aero Spacelines at Santa Barbara, California, in 1969, to TIFS configuration with a Boeing 707 nose spliced onto its nose. (Steve Nation)

Aspen Airways' Convair 580s operate under the United Express banner. (John Wegg)

an unofficial designation that was widely adopted, and put the type into service in June 1964. It was followed by Allegheny, AVENSA, Lake Central, and North Central. Still a popular and efficient aircraft today, 580s are operated by several US airlines including Aspen Airways, which now does business as a United Express carrier.

Four VC-131Ds were converted for the USAF and became VC-131Hs for the 89 MAW, Andrews AFB, Maryland. Three were transferred to the Navy at the same base in 1979 for VR-52 (later VR-48). A fifth conversion was made from a C-131B (53-7793) as part of the modifications to transform it into an NC-131H for the Total In-Flight Simulator (TIFS) programme developed by Cornell Aeronautical Laboratory, Buffalo, New York, for advanced transport aircraft. A lengthened nose incorporated a separate cockpit and movable control surfaces were mounted vertically above and below the wings and in this configuration a first flight was made on 8 July, 1970. In 1979, it was fitted with a digital computer in connection with the Space Shuttle programme and remained in use until 1986. In February 1987, it was used by Boeing to test flight control computer software and control configurations for its proposed 7J7 transport.

In 1967, the RCAF decided to convert eight of its Canadair 540s to Allison power with 4,050eshp 501-D36 engines and Hamilton Standard propellers (comparable to the C-130E) which increased cruising speed by 58mph over other 580s. The only other military operator was Bolivia, which acquired four ex-North Central aircraft in 1974 for TAM.

A second 580 was converted as an airline TIFS by Aero Spacelines, at Santa Barbara, in 1969 for Tex Johnston Inc. It had a Boeing 707 nose, but less expensive ground simulators prevented further production.

The structural integrity of the Convair-Liner airframe and the excellent record of the Allison 501 kept up the demand for the 580 well after conversion work stopped in July 1969. In 1984, Allison proposed a Super 580 (unofficially referred to as the 580A) with 4,269eshp 501-D22G Series 3 engines to increase maximum cruise by almost 40mph to 361mph with decreased fuel flow and modern avionics. As Aeroproducts propellers are now scarce, these were replaced with round-tipped Hamilton Standard ones.Two aircraft were so-modified, the first making a maiden flight on 21 March, 1984, at Tucson, Arizona. A 14ft 3in stretched fuselage version for up to seventy-six passengers, called the Allison Turbo Flagship (ATF) 580S, was marketed by Super 580 Aircraft Inc, a subsidiary of Flight Trails, parent company of Air Resorts Airlines of Carlsbad who ordered three. Tracor Aviation, Santa Barbara, also proposed building a similar stretched version, as has Kelowna Flightcraft, British Columbia, Canada, but no 580S aircraft have yet been built.

A third, more simple and less powerful propeller-turbine conversion programme was initiated in 1964 by Convair for all three series of Convair-Liners with 3,000eshp Rolls-Royce Dart R.Da 10/1 (Mk.-542-4) engines. Initially referred to as the 240-D, 340-D, and 440-D respectively, the designation Convair 600 (for ex-240s) was adopted in 1965 and Model 640 (ex-340/440s) in 1966 (the latter had originally referred to a twin-jet design, the Model 38) were adopted the following year. The first 600 (N94294 msn 178) made its initial flight from San Diego on 20 May, 1965, followed by the 640 (N73137 msn 88) on 20 August, and STCs were awarded on 18 November and 7 December, 1965, respectively.

Kits were also sold for airlines to make their own conversions which entailed few changes aft of the engine firewall. The Dart and four-blade Dowty-Rotol 13ft diameter propeller unit was attached to the original cowling but offset 8in from the original centreline to provide adequate airscrew clearance. Some structural strengthening was necessary, particularly for the 600, and two air compressors were added for pressurisation at the higher operating altitudes. An AiResearch APU in the starboard nacelle was optional. After initial flight tests, the beaver-tail fairing of the nacelle and exhaust tailpipe was extended to prevent interference of the recirculation of the engine exhaust on the flaps.

The first customer for the 600 was Central Airlines which ordered ten (converted by Convair). The first delivery was made on 19 September, 1965 (for crew training) and services began on 30 November. These were followed by twenty-five for Trans-Texas Airlines (later Texas International) converted by the airline, and three others.

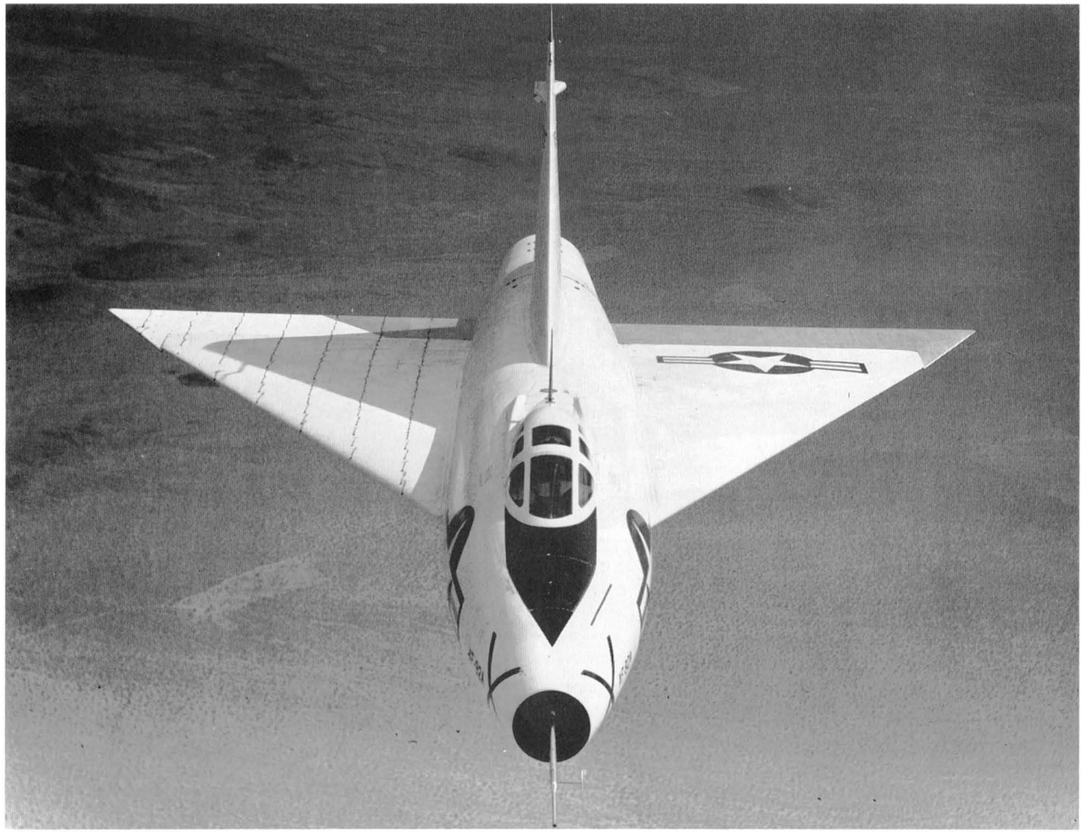
Hawaiian Airlines placed the first order for the 640 and the first of eight entered service on 23 December, 1965. However, a day earlier, the fourth Dart Convair customer, Caribair, had operated the first 640 service. Caribair's seven aircraft retained the two JATO units previously fitted to their 340s. In 1966, the 640 was re-certificated with a reduction in exhaust duct area to

Allegheny Airlines operated a large fleet of Convair 580s. (John Wegg collection)

Delivered new to Indonesia for Garuda Indonesian Airways, this Model 240-23 later returned to the USA, was converted to Dart-powered 600 standard, then went back to its former homeland with Seulewah Air Service. (Jay L Sherlock)

Hawaiian Airlines advertised its Model 640 Dart conversions as 'Jet Power Convairs'. (Gordon Reid)

increase thrust by 100lb and a Hydroaire anti-skid system. Larger diameter propellers with reverse pitch were offered as options. The first of the recertificated aircraft was delivered to Hawaiian. The first conversion in Europe was made by Aviolanda at Woensdrecht in The Netherlands, in 1966 for Martin's Air Charter and this had extra fuel capacity and seating increased to 56. Aviolanda also converted aircraft for Air Algérie and SATA of Switzerland. Scottish Aviation Ltd converted two for General Dynamics as demonstrators and the first (N7272) was flown on 19 September, 1966. In 1973, California Airmotive (later American Jet Industries) converted five of the Hawaiian aircraft to 640 Freighter standard for Zantop International with a heavy duty floor and a port side aft fuselage door. This modification is also available for Model 580s. A similar conversion with a 108in by 73in door was undertaken by Airfreighters International, Addison, Texas, in 1975. Subsequently, another four ex-Navy C-131Fs have been converted to 640s to bring the total to thirty-one.



The world's first powered delta-winged aircraft, the Model 7-002/XF-92A is shown here with the J33-A-29 engine with afterburner. (Convair)

Model 240:

Two 2,400hp (wet) Pratt & Whitney Double Wasp R-2800-CA3/CA15/CA18 or CB3/CB16 eighteen-cylinder air-cooled radial engines.

Accommodation: 40 seats.

Span 91ft 9in; length 74ft 8in; height 26ft 11in; wing area 817sq ft.

Weight empty 25,445lb (initial); 29,500-lb (revised); gross weight 40,500lb (initial); 42,500lb (revised).

Maximum speed 315mph; maximum cruising speed 280mph; initial climb 1,520ft/min; ceiling 16,000ft; range 1,200 miles (1,000-1,550US gal fuel capacity).

Model 440

Two 2,500hp (wet) R-2800-CB17 (or 2,400hp CB16s) eighteen-cylinder air-cooled radial engines.

Accommodation: 44-52 seats.

Span 105ft 4in; length 79ft 2in; height 28ft 2in; wing area 920sq ft.

Weight empty 31,305lb; gross weight 49,700lb (CB17).

Maximum speed 337mph; cruising speed 299mph at 13,000ft; initial climb 1,260ft/min; ceiling 24,900ft; range 1,300 miles (1,730US gal fuel capacity).

Model 580

Two 3,800eshp (wet) Allison 501-D13D or D13H propeller-turbines.

Accommodation: 44-56 seats.

Gross weight 53,200lb-58,156lb.

Maximum speed 360mph at 10,000ft; cruising speed 325mph at 10,000ft; initial climb 3,400ft/min; range 2,866 miles (1,730-2,908US gal fuel capacity).

Model 600

Two 3,000eshp Rolls-Royce Dart RDa.10 Mk.542-4 propeller-turbines.

Accommodation: 44-52.

Weight empty 30,200lb; gross weight 46,200lb.

Cruising speed 309mph at 15,000ft; range 1,900 miles (1,000-1,550US gal fuel capacity).

Model 7-002 XF-92A

In August 1945, the USAAF announced a competition for a supersonic interceptor capable of climbing to 50,000ft in four minutes and reaching 700mph. The design problem was worked on at Vultee Field by Jack Irvine, Frank W Davis, Adolph Burstein, and Ralph H Shick, culminating in a radical ramjet design, the XP-92, which won the contest in May 1946. Two wind-tunnel models had been built at Downey and one of these was subsequently tested to gather preliminary data. The results were immediately disappointing in that the 45-degree sweptback wing indicated tip stalls at small angles of attack along with lateral control problems. On 5 July, 1946, a historic notation appeared in chief designer Burstein's report, 'a 60-degree delta wing will be investigated this week'.

The delta planform was not new; prewar NACA theoretical studies had indicated high-speed advantages and in wartime Germany, Dr Alexander Lippisch had built a delta-winged glider, subsequently tested by NACA, which found the data encouraging but the wing thickness too great for supersonic flight. At Downey, fillets placed to fill in the internal angles of the XP-92 wing created a rough delta shape and consultation with Lippisch (then at Wright Patterson) confirmed that the Convair team was on the right track.

In order to speed development of the XP-92, in November 1946 the USAAF approved construction of a 60-degree delta-winged research aircraft, the Model 7-002. This designation was the accounting department's work order number and quickly became referred to as the 'Seven Balls Two' by the involved personnel. Further savings of time and money were achieved by using the main undercarriage from a North American FJ-1, nosewheel assembly from a Bell P-63, engine and hydraulics from a Lockheed P-80, ejector seat and canopy from a cancelled YP-81, and BT-13 rudder pedals. As the delta wing layout cancelled the traditional tailplane, combination aileron/elevator 'elevons' were developed and all flight-controls were hydraulically-actuated and irreversible. Construction was well advanced when Vultee Field was closed in summer 1947 and the airframe was completed at San Diego that autumn. In December, it was shipped to San Francisco and wind-tunnel-tested at NACA's Ames Aeronautical Laboratory at Moffett Field, Sunnyvale, then returned to San Diego for installation of a 4,250lb st Allison J33-A-21 turbojet. The Model 7-002 (46-682) was then taken to Muroc Dry Lake in April 1948 for flight testing by Sam Shannon. Tests were limited to taxiing and high-speed runs until a 5,200lb st J33-A-23 was available although a short 'hop' of a few feet was made on 9 June. Meanwhile, realising the impracticality of the ramjet engine for the XP-92, that programme was cancelled by the USAF and the 7-002 was designated XF-92A, allocated purely for delta research.

The first official flight of the 7-002 (and the first flight of a true delta-winged aircraft) was made on 18 September, 1948, and Shannon found the controls to be extremely sensitive. Phase 1 testing was shared with Bill Martin from 9 February, 1949, and was concluded on 26 August after 47 flights and 20$^{1}/_{2}$ hours. Capt Charles E 'Chuck' Yeager and Maj Frank K 'Pete' Everest then flew most of the 25 USAF test flights until the end of the year. Although the XF-92A was easy to land and exceptionally stable around Mach 0.9, it lacked the power to go supersonic in level flight and could only exceed Mach 1 in a dive, which it achieved once with Everest as pilot. However, Convair was convinced that it had found a satisfactory supersonic configuration and pressed forward with the F-102.

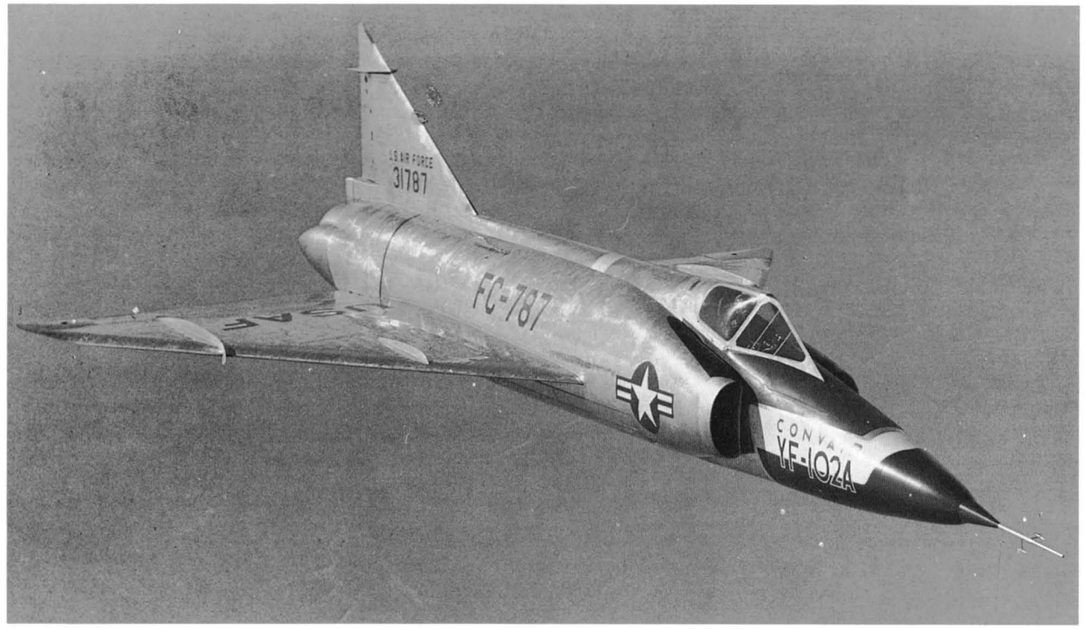
Refitted with a 7,500lb st J33-A-29 engine with afterburner, the XF-92A was reflown by Yeager on 20 July, 1951, but there was little improvement in performance. In contrast to previous experience, maintenance problems surfaced and in 19 months only 21 flights were made. A further engine change was made to the 8,400lb st J33-A-16 and on 9 April, 1953, A Scott Crossfield began flight tests on behalf of NACA. This series of tests revealed violent pitch-up movements in high-speed turns and wing fences were installed to partially solve the problem. On landing after its 25th NACA flight on 14 October, 1953, the XF-92A suffered a nosewheel collapse while taxiing at high speed and was withdrawn from service. Disposed of as a static exhibit, the XF-92A was rescued by the USAF in 1969 and is in storage for its museum at Wright-Patterson AFB.

One 5,900lb st (7,500lb st with afterburner) Allison J33-A-29 turbojet.

Span 31ft 4in; length 42ft 6in; height 17ft 9in; wing area 425sq ft.

Weight empty 9,078lb; gross weight 14,608lb (300US gal fuel capacity).

Maximum speed 718mph at sea level; 655mph at 35,000ft; climb 35,000ft/4.3 min; ceiling 50,750ft.



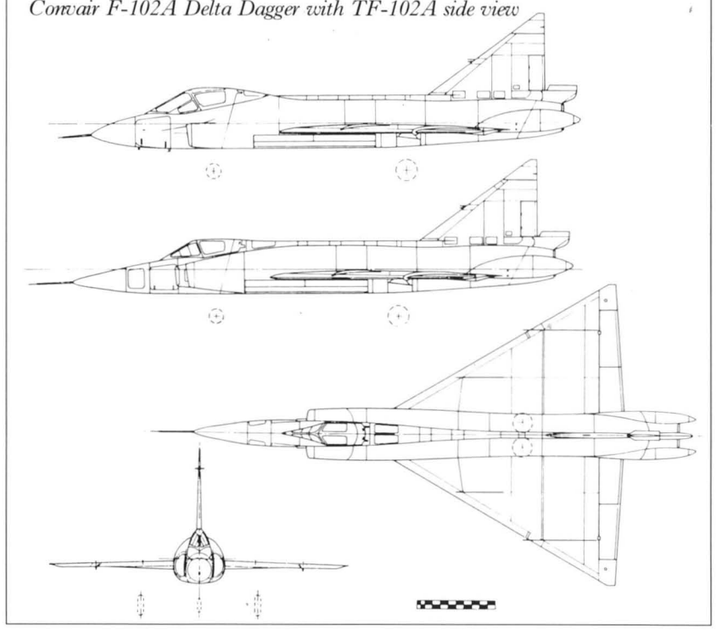
The Model 8-90 YF-102A was representative of the first 65 production Model 8-10 F-102As. (Convair)

Model 8 F-102 Delta Dagger

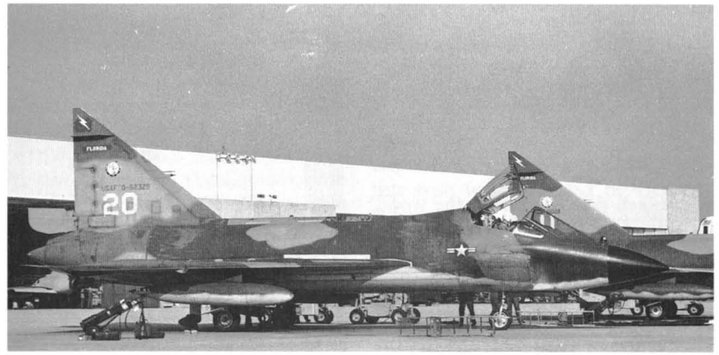
In the haste to demobilise following the Second World War, the USA was left almost undefended against air attack by 1947. There remained only a few obsolescent coastal radar stations, one squadron of Republic P-47s and one of Northrop P-61 night fighters for the whole country. Events abroad (especially the appearance of the Soviet Tu-4 bomber) showed the error of this policy. An interim system was organised around the Northrop F-89C and Lockheed F-94B and the 'Lash-up' radar network. But to develop a better defence by 1954, the aircraft and electronic industries were asked to participate in a conference at Air Force headquarters in May 1949. A new approach was introduced by Gens Muir S Fairchild and Gordon P Saville. Instead of issuing precise specifications, the Air Force outlined its problems and invited industry to submit proposals leading to an integrated weapons system – designated WS201A – optimised for the air defence role. As development of the complex electronic control system would take longer than the interceptor itself, that portion of the package, designated Project MX-1179, came first. A competition led to selection of the Hughes Aircraft Company's MA-1 fire control system and its Falcon (GAR-1) missile in May 1951.

The following month, a formal request to manufacturers for proposals for an airframe (Project MX-1554) was issued. From the nine proposals submitted by six manufacturers, Convair, Lockheed and Republic were chosen to proceed with preliminary development a year later, but on 11 September, 1951, Convair received a contract for its delta design which was designated F-102. The contract called for the initial test programme to be flown with the Westinghouse J40 turbojet with production aircraft fitted with the 15,000lb st Wright J67 (licence-built Armstrong Siddeley Sapphire). A new procurement policy, called the Cook-Craigie plan, named for Lt-Gen Orval R Cook and Laurence C Craigie, was tried for the first time for the F-102 programme. Instead of starting full-scale production as soon as the new model was accepted, the plan called for delivery of a modest number of aircraft during flight tests so that any major changes could be incorporated into permanent factory tooling in order for combat-ready F-102s to be delivered when mass production started.

Convair F-102A Delta Dagger with TF-102A side view



A camouflaged 32nd FIS TF-102A landing at its base at Soesterberg, Netherlands. (John Wegg collection)



A camouflaged TF-102A of the 159th FIS, Florida ANG, at Jacksonville. (John Wegg collection)

However, it was soon apparent that not all the advanced features would be ready in time for the '1954 Interceptor' and this problem, coupled with the substitution of the 14,500lb st Pratt & Whitney J57-P-11, led to a less ambitious schedule with an 'Interim Fighter' consisting of the F-102A with the J57 together with a partial development of the MA-1, the MG-3, with the F-102B being the designation of the 'Ultimate Interceptor'. Manufacture of a preliminary order for ten YF-102s (two Model 8-80s, 52-7994/7995, followed by eight Model 8-82s 53-1779/1786) began in April 1952.

The YF-102 was basically the XF-92A scaled up by 1.22:1 except for the slim nose and lateral air intakes. Structurally it was far different. A strong skeleton of milled aluminium spars and longerons, covered with aluminium skins, carried the fuel in wing spaces, the electronics in the fuselage and six GAR-1 missiles in a concealed ventral bay. In addition, twenty-four folding-fin aerial rockets (FFAR) could be fitted into channels contained in the fast-acting missile-bay doors. Trucked from San Diego to Edwards AFB, the first YF-102 flew on 24 October, 1953, with Richard L Johnson but was written off in a forced landing following an engine failure on its seventh flight, on 2 November . The second YF-102 flew on 11 January, 1954.

But more serious than the loss of the first aircraft was the discovery made during wind-tunnel tests earlier in 1953 that drag estimates were seriously wrong and that the F-102 intended for high supersonic speeds, would be incapable of exceeding Mach 1. To save the F-102, Convair decided to apply the area rule theory, conceived by NACA aerodynamicist Richard T Whitcomb, and undertook a major redesign to this principle with an 11ft longer fuselage pinched along the wing join in what became known as the 'coke bottle' or 'Marilyn Monroe' configuration. In addition, 'Whitcomb bodies' were added to the rear fuselage, a new canopy was fitted, the J57-P-23 substituted, and the aircraft lightened by reducing excess structures no longer required with the lighter Pratt & Whitney engine. Designated Model 8-90, the first of four YF-102As (53-1787/1790) was rolled out at San Diego just 117 days after redesign started and, after being trucked to Edwards, was flown by Johnson on 20 December, 1954. The following day Mach 1 was easily exceeded, but the height band for supersonic operation with the F-102A remained narrow.

Following a costly re-tooling, full-scale production began at Plant 2, San Diego, and the first Model 8-10 or F-102A flew on 24 June, 1955. In an attempt to gain some of the time lost, forty-five F-102As were used for test work at Edwards, nearby Palmdale, and Holloman AFB, New Mexico. The first delivery to an operational Air Defense Command unit took place on 1 May, 1956, almost three years later than originally envisioned, when Lt-Col Charles E Rigney, commander of the 327th Fighter Interceptor Squadron, delivered a F-102A to George AFB, California. Thus the Delta Dagger (named in 1957) became the first

TF-102A-45-CO 56-2364 of the New York ANG. (John Wegg collection)

operational delta aircraft in the world capable of exceeding Mach 1 and the first USAF fighter to enter service without any guns.

By spring 1956, with orders for 875 F-102As (53-1791/1818, 54-1371/1407, 55-3357/3464,56-957/1518, and 57-770/909) the type could no longer be considered interim and deliveries continued until September 1958. On 30 May, 1956, an initial contract was awarded for the 'ultimate' F-102B (Model 8-24), but in September the designation was officially revised to F-106A.

The remaining Model 8-80/YF-102 (52-7995) was refitted with a cambered wing leading edge, reflex wingtips, larger air-brakes, a taller fin to limit the effects of roll coupling, and prominent air intake splitters to reduce cockpit noise. With effect from the 66th aircraft (55-3357), these modifications were adopted for production aircraft, all of which were painted with a special grey paint to prevent corrosion from missile rocket blasts. Subsequently, most of these improvements were incorporated into the earlier aircraft. The last structural modification was the redesigned 'Case XX' wing introduced on Block 75 aircraft (56-1275 onwards).

A novel jettisonable cockpit was originally designed for the F-102 by Anthony Mastriana at the Wright Air Development Center. The upper part of the cockpit, with the seat and pilot moved to a supine position, together with the canopy and its rear fairing would have been separated from the aircraft as a pressure-tight box to withstand supersonic ejection. However, deceleration loads of 18g for several seconds forced the abandonment of this idea.

A side-by-side two-seat combat proficiency trainer version, the TF-102A (Model 8-12), was first flown on 31 October, 1955, by Johnson, the first of 111 (54-1351/1370, 55-4032/4059, 56-2317/2466). From the third aircraft (54-1353) all TF-102As had the taller tail, but excluding a dive manoeuvre, it remained subsonic.

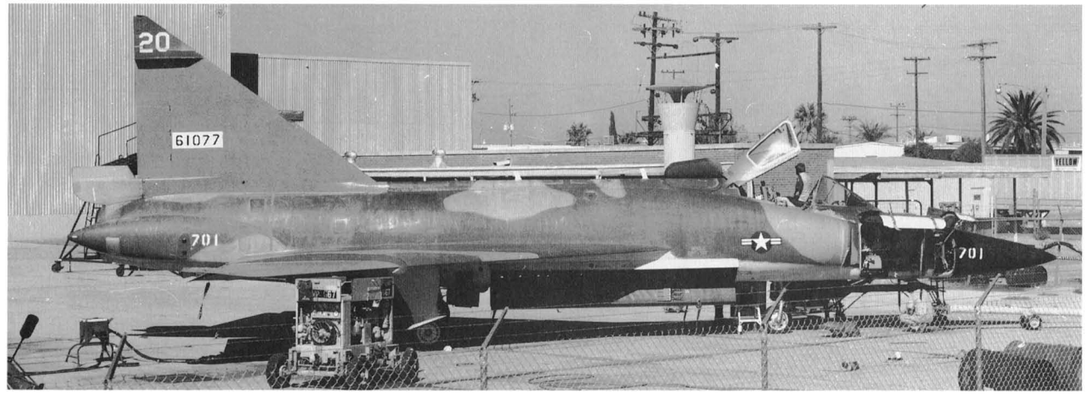
Another single-seat proposal was the F-102C (briefly known as the F-102X) with the J57-P-47 and structural modifications expected to increase performance in a tactical role. But this concept was rejected by the USAF in April 1957, although two aircraft (53-1797/1806) were used as YF-102C engineering test-beds and the former ended its days in a Honolulu technical school.

In 1957, Convair began a modernisation programme for early aircraft that continued for six years and which included the replacement of the MG-3 fire control system with the MG-10, the addition of wing drop tanks, and an infra-red sighting system. The original 2in rockets were replaced with 2.75in FFARs and eventually the rocket armament was discarded altogether to enable two nuclear-tipped AIM-26A Falcons (GAR-11) to be carried or up to six AIM-4 missiles, or a combination.

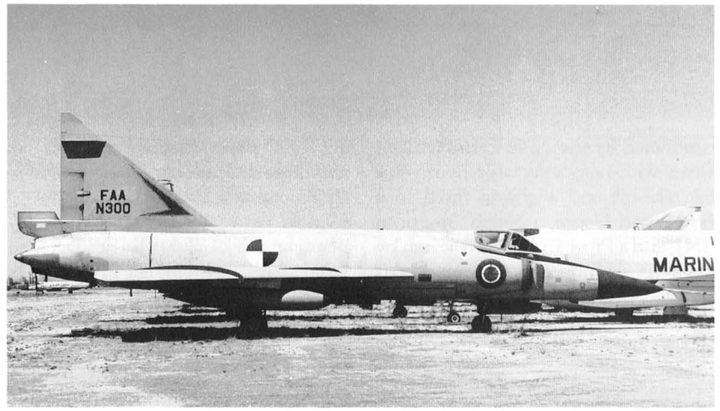
The F-102A replaced the North American F-86D as the most numerous interceptor and at its peak in 1958, was in service with twenty-six ADC and two Alaskan Air Command squadrons, including one (the 327th FIS) at Thule, Greenland. But after 1960, it was gradually replaced by McDonnell F-101B Voodoos and F-106A Delta Darts and most transferred to Air National Guard and USAFE units. The 182nd FIS, Texas ANG, at Kelly AFB, was the first to receive Delta Daggers in mid-1960 and was followed by twenty-two more units, including those in the states of Louisiana, Florida, Texas, North Dakota, Hawaii, Pennsylvania, New York, Washington, Connecticut, Oregon, Maine, Vermont, Tennessee, Arizona, South Carolina, South Dakota, Wisconsin, Minnesota, Montana, Idaho, and California.

A 1967 proposal to modify F-102As into RF-102s as the standard ANG reconnaissance aircraft was not proceeded with nor was an idea to refit aircraft for in-flight refuelling as the large probe mounted immediately aft of the cockpit would have seriously reduced performance. At the end of the decade Convair also proposed a close air support mission version with an internal Gatling gun, but again this was stillborn.

The first squadron in Europe to receive F-102As was the 525th FIS at Bitburg, West Germany, which received twenty-five aircraft between January and March 1959. Five other squadrons based in West Germany, Spain and The Netherlands followed. F-102As were also passed to a few PACAF squadrons, the first being the



A PQM-102A drone under conversion by Sperry. (A R Krieger)



F-102A N300 used by the Federal Aviation Agency. (John P Stewart)

16th FIS at Naha AB, Okinawa, which re-equipped in March 1959. Aircraft from the 509 FIS were transferred to Tan Son Nhut AB, South Vietnam, in March 1962, and the *Deuce* (as it was known) remained there and in Thailand until 1969 operating air defense missions. Large-scale retirement of the F-102 began in late 1969, although the last ADC unit, the 57th FIS at Keflavik, Iceland, did not replace its aircraft (with McDonnell F-4C Phantoms) until mid-1973. The last operational flight by a USAF F-102A was made on 22 October, 1976, by two aircraft of the 154th TFG, Hawaii ANG, from Hickam AFB, Honolulu.

Approximately fifty F-102As and TF-102As were transferred to Turkey from USAF stocks (after overhaul by CASA at Seville) beginning in 1968 and assigned to Nos.142 and 181 Squadrons at Murted and Merzifon respectively until the end of the decade. Greece acquired about half that number for 114 Wing at Tanagra. One F-102A (N300) was used by the FAA to evaluate the effect of high-speed aircraft on the Air Traffic Control system and another (54-1398) was used by General Electric to test the J85 turbojet, with the engine positioned below the fuselage. Another 'civil' aircraft was used by a technical school in Montana (N8970 ex-56-1116).

In 1973, Sperry Rand converted six aircraft from the nearly four hundred F-102As stored at Davis-Monthan, Arizona, into QF-102A piloted drones at nearby Goodyear for use as targets in the McDonnell Douglas F-15 development programme. The first flight was made in March 1974. Subsequently, Sperry converted sixty-five aircraft under the *Pave Deuce* programme as true drones, designated PQM-102A and nicknamed *SPADs*, for anti-aircraft missile training and the first flew at Holloman AFB, New Mexico, on 13 August, 1974. This was the first full-scale drone with afterburner and believed to be the first full-scale drone without provision for a pilot. Later aircraft were delivered in *Bare Bones* configuration, with redundant systems removed and scaled-down electronics to reduce cost. The first of this type was converted by Sperry's subcontractor, Fairchild Aircraft Services, and the first flew at its Crestview, Florida, facility on 17 February, 1977. The US Army acquired seven PQM-102As for use in evaluation of Stinger and SAM-D missiles at White Sands, New Mexico, and the remainder were used by the USAF at Tyndall and Holloman.

A further contract for sixty-six PQM-102Bs with remote control electronics in the nose instead of the cockpit to enable piloted flight was awarded to Sperry in 1978 and a further eighty were also converted to this standard at Goodyear. The last PQM-102B (61072) was manually flown by RCA Services Corporation until expended at Holloman in 1986, but many examples of the F-102A remain preserved in museums and at USAF bases.

F-102A-CO (Model 8-10)

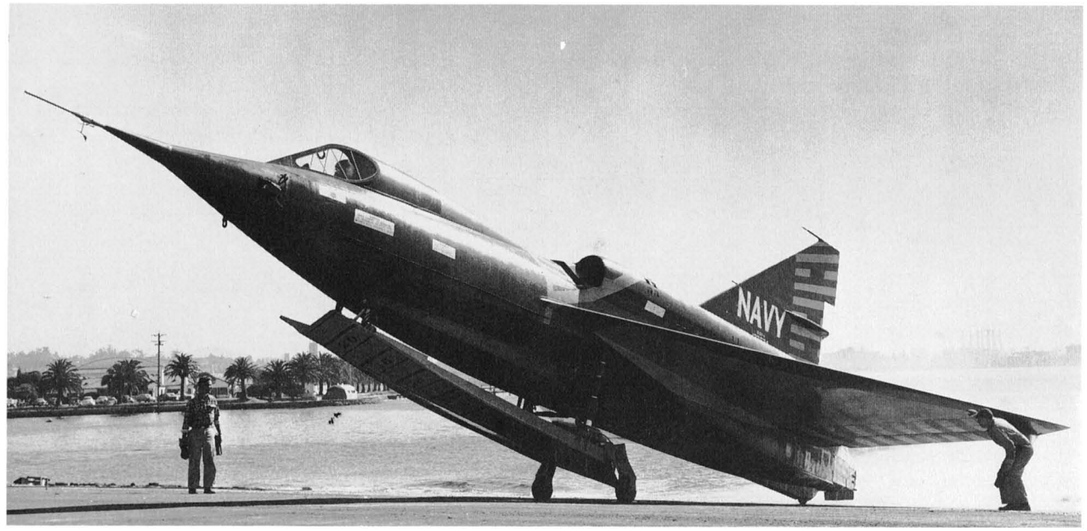
One 17,000lb st Pratt & Whitney J57-P-25 turbojet with afterburner.

Armament: Six Hughes GAR-1D later-2A Falcon air-to-air guided missiles and twenty-four 2.75in folding fin rockets. Later typical load was six AIM-4C, -4D,-4E, -4F Falcons or three Falcons plus one AIM-26A or -B.

Span 38ft $1^1/_2$ in; length 68ft 5in; height 21ft $2^1/_2$ in; wing area 661.5sq ft.

Weight empty 19,050lb; maximum gross weight 31,500lb.

Maximum speed 825mph at 36,000ft or Mach 1.25; initial climb 13,000ft/min; service ceiling 54,000ft; maximum range 1,350 miles (515-1,085US gal fuel capacity).



XF2Y-1 BuA 135763 during tests with a revised twin-ski layout in 1955. (B J Long collection)

Model 2 F2Y Seadart

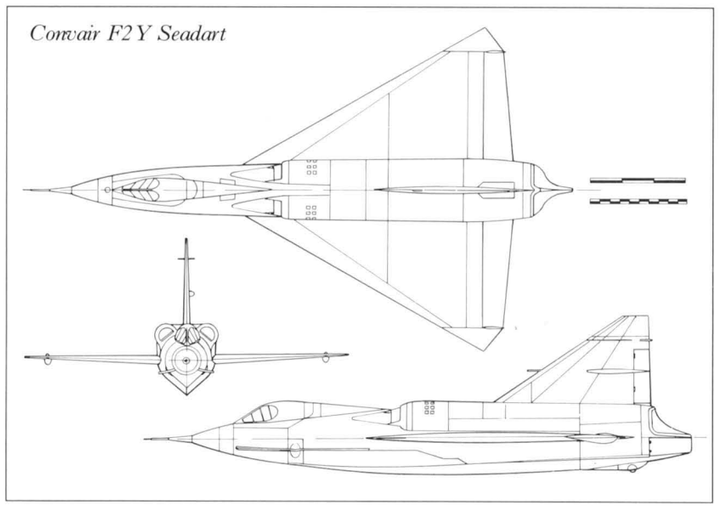
Following the design studies that led to the Model 117 P5Y, Convair's hydrodynamic research laboratory, under the leadership of Ernest G Stout, turned its attention to the refinement of water-based aircraft for high-speed flight. Starting with the Model 109 XB-46 as a basis, seven design studies with blended hull and wings, each improved upon from the earlier trials, were tested in jet-powered radio-controlled scale-model form under the name Project Skate with the aim of realising an optimum aerodynamic form. Eventually this led to a delta design with blended hull which rested on the water and rose up on a retractable step for take-off and alighting. Convair also tested a large number of seaplane designs with hydro-ski configurations towed by high-speed boats.

Stout also attracted Navy interest in his concept of a mobile base whereby a family of water-based aircraft could operate from sheltered water areas supported by naval vessels. The advent of the jet engine and the research at San Diego and by NACA indicated that a fighter-type aircraft, formerly considered impractical, was now possible and in 1948, work began on the actual development of a supersonic seaplane fighter. A design contest was announced on 1 October, 1948, and Convair's blended hull was chosen for further development.

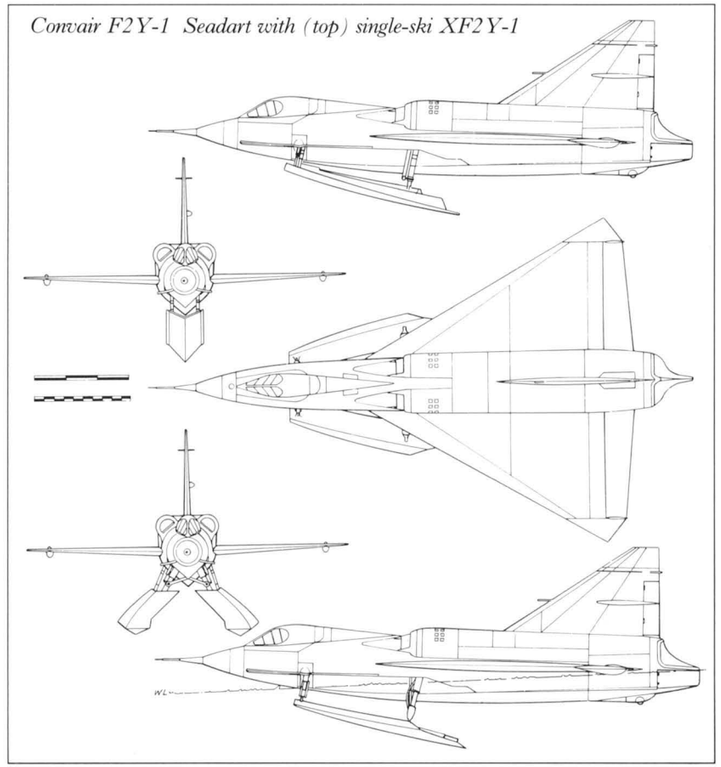
However, successful experiments conducted by the NATC at Patuxent River with non-retractable hydro-skis for take-off and alighting fitted to a Grumman Goose, a North American SNJ, and a Piper Cub, and research by the NACA, indicated that an aircraft so-fitted would be more compact and offer better performance than originally thought. Therefore, after comparative trials with scale models by Convair, the Navy authorised two prototypes (BuA 137634/137635) on 19 January, 1951, along this latter concept. Patterned after the YF-102 and known until August as the Model Y2-2, the XF2Y-1 was later named Seadart.

Two 6,100lb st Westinghouse XJ46-WE-2 engines were planned but pending availability, the Seadart was fitted with 3,400lb st J34-WE-32s mounted side-by-side above the 60-degree thin delta wing and fed through inlets on the top of the fuselage. Of aluminium construction, the Seadart had multiple watertight compartments in the lower fuselage to prevent sinking in the event that the hull was punctured. Both the elevons and rudder were hydraulically powered and an unusual feature was combination dive-brakes/water-brakes/water rudder. The twin retractable hydro-skis had 10in aluminium wheels, with hard rubber tread, mounted on the aft end and a small swivel tailwheel allowed some manoeuvrability on the ramp. The Seadart taxied down the ramp into the water with partially-extended skis. For take-off, the ski oleos were fully extended, then as power was applied and the leading edge of the ski broke the water at 8-10kt (9-11mph), the electrically-actuated hydraulically-operated skis were then placed in an intermediate position until 40-50kt (46-57mph) was reached. The maximum extended position was then selected and the aircraft accelerated for lift-off at around 125kt (144mph).

Convair F2Y Seadart



Convair F2Y-1 Seadart with (top) single-ski XF2Y-1



Following a mock-up inspection, a contract for twelve F2Y-1s was placed on 28 August, 1952, later modified to include four YF2Y-1s. Subsequently, the order was increased to a total of 22 aircraft. Proposed armament was four 20mm cannon and 2.75in rockets.

On 14 December, 1952, E D 'Sam' Shannon began taxi-ing trials with the first XF2Y-1 (BuA 137634) and on the following 14 January made an inadvertent first 'hop' of 1,000ft. An official first flight was made on 9 April, 1953, delayed because of severe vibration and aircraft pounding caused by the blunt afterbody of the skis traversing wave patterns. A redesign of the ski and improved ski oleos reduced the extent of this problem. But flight tests revealed that the Seadart in its present aerodynamic form, ie without the application of the area rule principle, could only reach Mach 0.99 in level flight. As the XJ46-WE (installed in the prototype in 1953) failed to reach the projected thrust, Convair proposed a single 12,000lb st Wright J67 or 15,000lb st Pratt & Whitney J75 engine for an improved version, the XF2Y-2, with a single hydro-ski. But this action would have entailed an almost completely new aircraft and together with the development delays, resulted in the questioning of the whole concept by the Navy. Thus, on 14 October, 1953, the remaining XF2Y-1 was cancelled in favour of completion as a YF2Y-1, followed by the cancellation of all production F2Y-1 aircraft in March 1954.

The YF2Y-1, the second Seadart built (BuA 135762) was completed in spring 1954 for aerodynamic and high-speed flight testing conducted by Charles E 'Chuck' Richbourg. On 3 August, 1954, Richbourg exceeded Mach 1 in a shallow dive at 34,000ft, which made the Seadart the first and to date only supersonic seaplane. Open sea tests were also made which included recoveries by a Landing Ship Dock (LSD) vessel. Then, on 4 November, 1954, during a public demonstration at San Diego, Richbourg was killed when the YF2Y-1 structurally disintegrated during a low-level, high speed fly-past as a result of pilot-induced pitch oscillation.

YF2Y-1 BuA 137634 fitted with a single hydro-ski taxiing out of the water at San Diego. (B J Long collection)

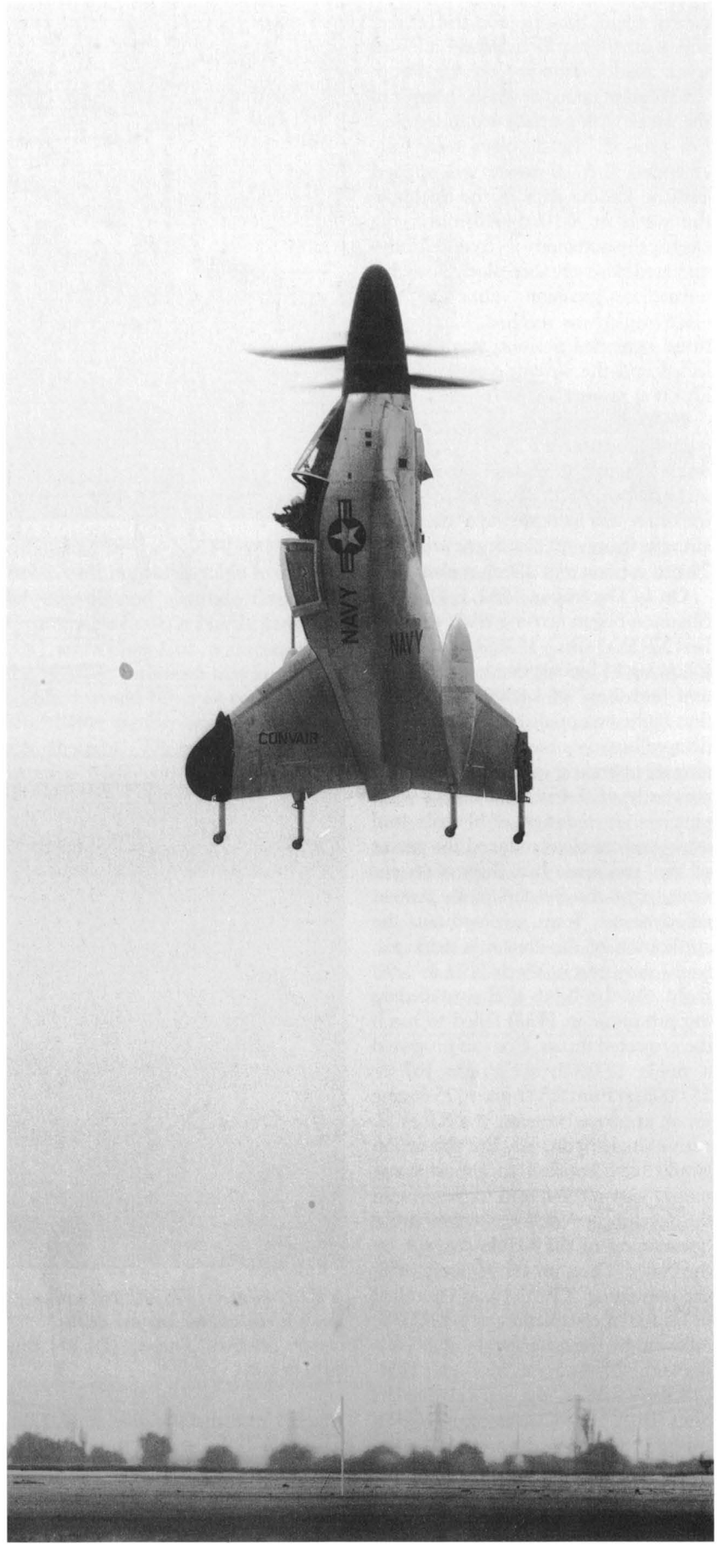
During summer 1954, the XF2Y-1 had been reworked with the aft fuselage to YF2Y-1 configuration and a

large single hydro-ski, only partially retractable because high-speed testing was unnecessary. Following the resumption of Seadart testing after the fatal accident, the XF2Y-1 was first flown in this configuration by B J Long on 29 December, 1954. Long also made the initial flight of the third Seadart (YF2Y-1 135763) on 4 March, 1955, which featured a revised twin-ski layout but vibration was still unacceptable and after open sea trials, testing ended with the second YF2Y-1 on 28 April. However, after refinements, the single ski performed well, even safely allowing crosswind take-offs and alightings with a wingtip dragging in the water. Testing with the single hydro-ski continued up to 16 January, 1956, when Long demonstrated the limit of this configuration in waves 6-10ft high, far greater than operational requirements.

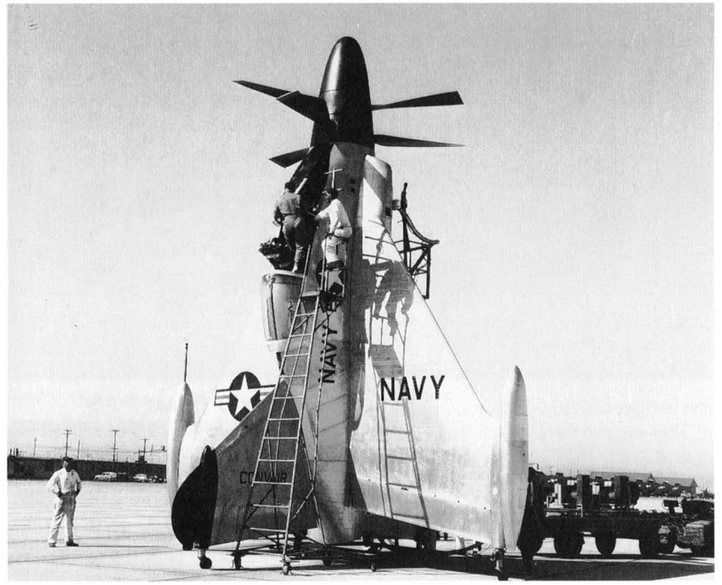
Later that year, the XF2Y-1 was fitted with a small rigidly-mounted ski which also had a hydrofoil shape, unlike the earlier planing skis, but taxiing tests made by Long during March and April 1957 indicated that a take-off was impossible because the 17-19-degree nose-up attitude required for take-off could not be achieved and severe pounding restricted speeds to 50-60kt (57-69mph). A similar rigid ski of reduced size was tested on the XF2Y-1 in autumn 1957 by Don P Germeraad with similar results.

During a period of 46 months, including 28 after the loss of the first YF2Y-1, over three hundred flights had been completed, some two hundred and fifty by the XF2Y-1. Despite satisfactory results with the large single-ski configuration, no further work was undertaken because of the lack of an approved operational requirement for such an aircraft. Curiously, the type was redesignated YF-7A in 1962, six years after the final flight of the XF2Y-1.

Because of the uniqueness of its design, all four surviving Seadarts (the last two aircraft were not flown) are displayed today. The XF2Y-1 is with the Maryland Aviation Historical Society at Strawberry Point, and the YF2Y-1s are at the San Diego Aerospace



XFY-1 BuA 138649 demonstrating its vertical take-off and landing capability. (Convair)



Entry to and egress from the cockpit of the XFY-1 was a challenge for the pilot. (Convair)

Museum (135763), NAS Willow Grove, Pennsylvania (135764), and Lakeland, Florida (135765) respectively.

Two 5,725lb st Westinghouse J46-WE-12B turbojets.

Span 33ft 8in; length 52ft 7in; (YF2Y-1 No.3 51ft 1 1/2 in); height 16ft 2in (20ft 9in skis down); wing area 568sq ft.

Weight empty 12,625lb; gross weight 16,527lb (YF2Y-1, 22,000lb).

Estimated performance for YF2Y-1 with J46s: Maximum speed 994 mph at 35,000ft; climb 35,000ft/ 1.7min; service ceiling 54,800ft; range 513 miles (630US gal fuel capacity).

Model 5 XFY-1 'Pogo'

Following the capture of data from German studies into the possibility of vertical take-off and landing (VTOL) both the USAAF and Navy issued study contracts to industry in 1947. A year later, the Navy organised a more specialised study for VTOL fighters capable of operating off platforms mounted on the afterdeck of ordinary cargo ships and in 1950, this was converted into a requirement for research aircraft capable of development into operational convoy escort fighters. In March 1951, three examples (BuA 138648/138650) of a Convair submission were ordered, along with a contract for the similar Lockheed XFV-1 design.

The Convair XFY-1, nicknamed 'Pogo', was a tail-sitting design with a short fat fuselage with stubby delta wings and a pair of large vertical fins above and below the fuselage. The ventral fin was jettisonable to permit an emergency landing in conventional wing-supported mode, and the assembly rested on small castoring wheels at the tips of the wings and fin. On take-off, the Pogo was to ascend vertically, then nose over into a conventional attitude. To land, the aircraft was flown into a nose-high position, then allowed to descend under gradually reduced power.

For the Pogo, Allison coupled two T38 propeller-turbines to make the 5,850ehp Allison YT40-A-6 which drove Curtiss-Wright 16ft coaxial, contra-rotating, turbo-electric propellers. Later, a 6,955ehp XT40-A-16 was planned and Allison eventually proposed supplying the twinned T56 as the XT54 with around 7,500shp. The cockpit, reached via a special ladder, had the single ejector seat mounted on gimbals to tilt 45 degrees when the aircraft was in a vertical position. The proposed armament comprised four 20mm cannon in wingtip pods or forty-eight 2 3/4 in folding-fin rockets.

In order to prepare James F 'Skeets' Coleman to fly this unique aircraft, a simulator consisting of an engine and fuselage section that could rise five feet when tethered to a test stand was completed. The prototype (138649) was then attached to an elaborate system of cables and tension regulators running to a powered drum mounted under the 184ft roof of a hangar at NAS Moffett, California. This restraint allowed the aircraft to rise and fall freely, but limited lateral displacement.

During summer 1954, Coleman made many short vertical 'flights' in the hangar then on 1 August, made the first untethered vertical flight to 40ft. Over the next two days, the XFY-1 was flown up to 150ft, then returned to San Diego for further tests at NAAS Brown Field. The transition to horizontal flight was made on 2 November, 1954, and the XFY-1 cruised for 20 minutes before returning and landing in a 50ft square. Flights were also made from Lindbergh Field and for these, the first successful VTOL flights ever (other than by helicopter or autogiro) Coleman was awarded the Harmon Trophy.

The XFY-1 proved extremely difficult to land safely on a consistent basis, and coupled with confusing hovering controls, inadequate pilot's view of the landing area, unusual pilot's posture, ejection danger, and questionable reliability of the XT-40 propeller-turbine (the same engine used on the R3Y Tradewind) led to the programme's cancellation after 40 hours of flying.

One airframe (138648) was used as an engine test-bed and the third (138650) for static tests and neither was flown. However the other, previously displayed at NAS Norfolk, is currently stored at the NASM's Paul Garber restoration facility in Maryland.

One 5,500shp Allison XT40-A-6 propeller-turbine.

Span 27ft 7 3/4 in; length 34ft 11 13/4 in; vertical span 22ft 11in, wing area 355sq ft.

Weight empty 11,742lb; gross weight 16,250lb.

Estimated performance (with XT40-A-16):

Maximum speed 610mph at 15,000ft; 592mph at 35,000ft; initial climb 10,500ft/ min; 20,000ft/2.7 min; 30,000ft/4.6min; service ceiling 43,700ft; endurance one hour at 35,000ft (580US gal fuel capacity).

Model 8 F-106 Delta Dart

Officially designated F-102B (Model 8-21) until 17 June, 1956, the F-106A was the original concept for the '1954 Interceptor' programme (WS 201B) that slipped with the F-102A development problems. With Cold War tensions increasing, emphasis was placed on achieving operational status with the F-102A rather than treating it as an interim design. Thus, only seventeen F-102Bs (56-451/467) were ordered on 28 April, 1955, with Pratt & Whitney J75-P-9s instead of the intended and ailing Wright J67 (licence-built Bristol Olympus), now a year behind schedule. The following September, the USAF specified that the new aircraft would become available in August 1958 and that the F-106A was expected to be able to intercept targets under the control of Semi-Automatic Ground Environment (SAGE) centres up to a radius of 430 miles and 70,000ft altitude and launch nuclear missiles and rockets with the Hughes MA-1 fire control system. Later this requirement was reduced to 50,000ft.

F-106B-1-CO (Model 8-27) 59-0162 of the 84th FIS at Hamilton AFB, California, in July 1969. (John P Stewart)

The wing of the F-106A was similar to that of the F-102A, but the fuselage was extensively modified with a more streamlined shape with the variable ramp air intakes moved well aft of the nose, closer to the engine. The fin and rudder shape was also changed and a new undercarriage installed with steerable twin-nose-wheels. As on the F-102, the armament was housed internally but upgraded to two Douglas MB-1 (AIR-2A or 2B) Genie unguided nuclear missiles and four Hughes GAR-3 or -4 (AIM-4E or G) Falcon radar or infrared homing missiles.

F-106A-90-CO (Model 8-24) 57-2504 posed aga inst the backdrop of the southern Sierra Nevada range during a pre-delivery test flight. (Convair)

The first flight was made by Richard L Johnson at Edwards AFB on 26 December, 1956, and the second aircraft (56-452) flew exactly two months later. Early testing took the F-106A to Mach 1.9 and 57,000ft but that was still short of expectations because of airframe design problems and the poor reliability of the J75-P-9 engine. Eventually this prompted the use of the more powerful 17,200lb st-17. Early in 1957, the whole programme was in jeopardy because of budget cuts and further problems, including those with the MA-1 and the cockpit layout. Originally, the control column occupied the tradition centre location but was moved to the side at USAF insistence to allow an unrestricted view by the pilot of the Horizontal Situation Indicator (HSI). However, the USAF changed its mind again and the column, with a unique two-handed grip for both aircraft and radar control, was returned to the centre for production aircraft. Convair also proposed an ejection system in which the seat rotated and pilot emerged feet first and on his back. A more conventional method was adopted, although this was not upgraded to supersonic capability until 1960. Initial aircraft had boundary layer fences as on the F-102, but production aircraft had wing leading-edge slots instead.

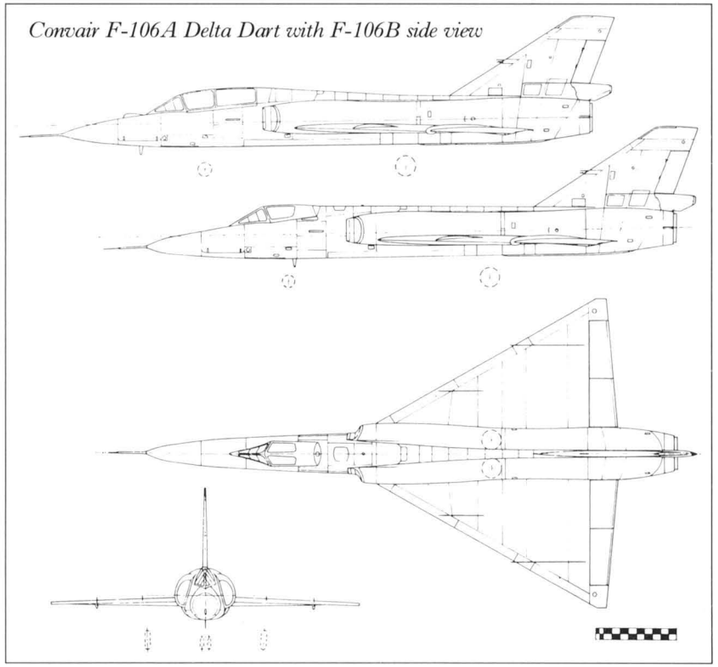
In mid-1957, when the type was named Delta Dart, it was planned to acquire one thousand aircraft for forty Air Defense Command (ADC) squadrons but by September 1958 the total had been reduced to a third, enabling just fourteen squadrons and a training unit to be equipped. Thus, only a further 260 F-106As were ordered (57-229/246, 57-2453/2506, 58-759/798, 59-1/148) and modifications brought the earlier aircraft up to this Model 24 standard. The first twelve aircraft were temporarily designated JF-106A for flight tests but a total of thirty-seven (including the two initial aircraft) were used to speed development tests.

Additionally, sixty-three tandem two-seat Model 8-27 (57-2507/2547, 58-900/904, 59-149/165) were ordered on 3 August, 1956, and the first flight was made on 9 April, 1958. The layout was chosen to avoid the problems experienced with the side-by-side trainer version of the F-102 and the aft cockpit reduced fuel capacity and displaced the avionics to the weapons bay. Originally intended as a pure trainer designated TF-102B then TF-106A, F-106B was eventually used when full combat capability was specified by the USAF. The first eight aircraft were temporarily designated JF-106B for flight tests and the first delivery made in February 1959. However, the F-106B suffered from the same development problems as the single-seater and was not declared operational until July 1960.

F-106A-1-CO 58-0774 of the 194th FIS, California ANG, on approach to its base at Fresno in November 1976. (John Wegg)

Production continued until December 1960, the last aircraft being Model 8-31s and 8-32s (F-106Bs) with improved MA-1, supersonic ejector seat, vertical display instrument panels, Case 29 wings with revised camber (first flown on 57-246), and with provision for 230US gal external fuel tanks.

Convair F-106A Delta Dart with F-106B side view



Under the project name *Wild Goose*, most of the earlier F-106As were rebuilt by Convair to this standard from September 1960. Throughout its long service life, the F-106 was constantly upgraded. In late 1960, *Broad Jump* covered general improvements, the *Dart Board* (August 1961-April 1962) provided a thermal flash hood, Convair ejector seat, plus addressed a flame-out problem, and in 1963, aircraft were fitted with a Sheaffer Spring Hook arrestor system, the first USAF combat aircraft so-equipped, following tests with the prototype four years earlier. TACAN (Tactical Navigation) and zero-zero ejector seats were installed in 1965, inflight refuelling capability two years later, plus supersonic 360US gal external tanks, and in 1972, a clear canopy for improved vision. After the F-106 exhibited a remarkable dog fighting ability, a 20mm Vulcan cannon was fitted internally to some aircraft although this modification (project *Six Shooter*), along with the new canopy, was not adopted for the F-106B. At the same time, ECM and early-warning avionics were installed.

A number of other Delta Dart models were proposed but remained unbuilt. Originally known as the F-106X, the F-106C/D (Model 8-28/8-29) was a 1956 study for a Mach 5 canard layout interceptor with a Pratt & Whitney J75, rectangular intakes and a 40in radar dish. On 23 September, 1958, a proposed 350 aircraft were cancelled but two F-106As (57-239/240 msn 8-24-8/9) were designated YF-106Cs and made ten flights to test the new radar housing with a 5ft nose extension from spring 1959. The F-106E/F was proposed with a look-down radar in a 21in extended nose. In 1967, the second use of the F-106X designation covered the plan to modify over two hundred F-106s structurally and with improved avionics at $5 million each to undertake the Improved Manned Interceptor role. The modified Dart would have had a range of 1,500 miles plus Mach 2 capability and operate in conjunction with AWACS.

First deliveries of the F-106A were made to the 498th FIS, Geiger AFB, Washington, in May 1959, and the Dart was operational by 31 October that year. The remaining 13 squadrons were re-equipped by the end of the following year and the last Dart was delivered on 20 July, 1961. On 15 December, 1959, a Dart flown by Maj Joseph W Rogers at Edwards regained the absolute speed record for the USA with a speed of 1,525.6mph at 40,550ft and although this was lost two years later, the single-engined aircraft speed record was held far longer. Another F-106, flown by Maj Frank Forsyth, achieved a nonstop Edwards–Tyndall AFB, Florida, flight on 23 March, 1960, completely under automatic ground control. Although it was briefly deployed to Osan AB, Korea, in March 1968 to provide air defence during the *Pueblo* incident, the Dart never saw combat.

F-106A-1-CO 56-460 of the 5th FIS, Hamilton AFB, California, in July 1969.

During the early 1970s, as no replacement aircraft were in sight, surviving F-106s with eleven ADC squadrons had their service life increased from 4,000 to 8,000 hours. From 1972, the McDonnell Douglas F-15 started to replace the Dart and aircraft were passed to six ANG squadrons in California, Florida, Massachusetts, Michigan, Montana, and New Jersey. The last of these squad-rons eventually re-equipped with the F-16A and the last Dart unit, the 119 FIS at Atlantic City, New Jersey, flew its final alert duty with the F-106 on 7 July, 1988, and by 20 August, all its aircraft had been ferried to Davis-Monthan AFB, Arizona. Despite having the heaviest pilot workload of any USAF fighter, the F-106 recorded the lowest single-engined aircraft accident record in USAF history.

A *Pacer Six* programme for the conversion of 192 Darts stored at Davis-Monthan AFB, Arizona, to QF-106As started early in 1986 and a contract was awarded to Flight Systems Inc at Mojave, California. First flown in July 1987, the target drones will be expended at Tyndall and Holloman from 1989.

Two NF-106Bs (N607NA ex-57-2507, N616NA ex-57-2516) were used by NASA as systems development aircraft. The second of these (re-registered N816NA) was modified by the Langley Research Center in 1979 to evaluate the effect of lightning strikes on aircraft. In 1987, it was fitted with Langley-designed and manufactured wing leading-edge vortex flaps in connection with the Advanced Technology Fighter programme and made the first of thirty planned flights on 2 August, 1988, with Philip W Brown.

Two other manned Darts were still in use in early 1990, an F-106A (59-0061) and an F-106B (57-2513), both used as Rockwell B-1 chase aircraft by the San Antonio Air Logistics Center at Kelly AFB, Texas.

F-106A

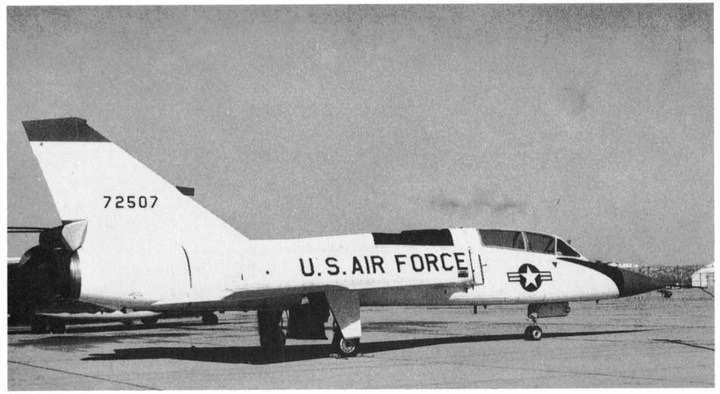
One 16,100lb st Pratt & Whitney J75-P-17 turbojet (24,500lb st with afterburner).

Armament: One AIR-2A Genie plus four AIM-4F/G Falcons internally; the Genie was later replaced in some aircraft by a General Electric M61A1 20mm Vulcan cannon.

Span 38ft $3^1/_2$ in; length 70ft $8^3/_4$ in; height 20ft 3in; wing area 697sq ft.

Weight empty 24,861lb (F-106B 25,696lb); gross weight 41,831lb (F-106B 42,720lb).

Maximum speed 1,328mph at 35,000ft; cruising speed 594mph; climb 51,800ft/6.9min; service ceiling 52,700ft; combat radius 725 miles (with external tanks); ferry range 1,809 miles.



Air Force System Command NF-106B (Model 8-27) 57-2507 at Edwards AFB, May 1972.
(Jay L Sherlock)

The 36th B-58A, 59-2433 of the 43rd BW, Little Rock, Arkansas.
(General Dynamics)

Model 4 B-58 Hustler

Convair had been involved with paper studies for a new strategic bomber for the USAAF since October 1946 under the contract acronym GEBO I (Generalised Bomber Study I) and more defined research had continued with GEBO II, issued in March 1949. By January 1951, a delta-winged design had been chosen, and in February, the contract designation MX-1626 was issued to cover a long-range supersonic joint bomber/reconnaissance type. In December 1951, the USAF issued a general operational requirement (GOR) and Convair's design was renumbered MX-1964 and gradually evolved into the B-58. In October 1952, the B-58 was chosen over the competing Boeing B-59 and detailed design work continued until August 1954 for a bomber and a reconnaissance version (the RB-58) with the weapons system concept designations WS 102A and WS 102L respectively. Following mock-up inspection at Fort Worth, orders were placed on 13 October, 1954, for thirteen test aircraft (55-660/672) designated YB/RB-58A.

Powered by four General Electric J79-GE-1 engines housed in individual underwing pods, the B-58 featured an area-ruled fuselage and large-scale use of bonded honeycomb sandwich skin panels to resist high temperatures at Mach 2. Two eight-wheel bogie stalky main undercarriage legs were necessary to provide clearance for the nacelles and a fuselage underslung weapons pod. Originally, this was to have been an MA-1C air-to-surface missile pod but this was replaced by a 57ft long MB-1C pod containing a W39Y1-1 nuclear weapon and 4,172US gal of fuel, the weapon released at Mach 2 and 55,000ft following a climb-toss manoeuvre from a low-level Mach 0.91 approach. From 1960, a two-component pod (TCP) with 3,885US gal of fuel in the lower compartment (dropped after exhaustion) and BA53-Y1 weapon, cameras,

The prototype B-58A with red and white nose and tail colours, a contrast to the plain aluminium finish of service aircraft. (General Dynamics)

ECM, or other equipment in the upper portion, was used. In the event, the MC-1 and MD-1 reconnaissance pods were cancelled and the Hustler, officially so-named in 1956, was produced only in the bomber version. Standard SAC ejector seats were originally installed for the three crew (pilot, navigator/bombadier, and defensive systems operator) who sat in separate tandem compartments, but later an encapsulated ejector seat was developed. A 20mm cannon was installed in the tail position.

The first aircraft (55-660) made its maiden flight, without a pod, on 11 November, 1956, from Fort Worth piloted by Beryl A Erickson and reached Mach 1 on 30 December. The first flight with a pod was made on 16 February, 1957, and Mach 2 achieved on 29 June that year. To support an extensive test programme, which resulted in the loss of seven aircraft, a further seventeen trial YB/RB-58As (58-1007/1023) were ordered and the last of these (58-1023) was completed to full production standards. An additional airframe, not allocated a serial number, was used at Wright-Patterson for fatigue testing after being transported from Fort Worth in the belly of a B-36. The production J79-GE-5 engine was tested on the seventh aircraft (55-667).

Production orders were placed for eighty-six B-58A-CFs (59-2428/ 2463, 60-1110/1129, 61-2051/2080) with J79-GE-5A engines and deliveries began on 15 March, 1960, to the 43rd BW at Carswell and from 11 May, 1961, to the 305th BW at Bunker Hill AFB, (now Grissom AFB), Indiana, and were completed in October the following year. In addition, eleven of the second trials batch were modified to B-58A standard in 1961. Overseas

The prototype B-58A taking off from Fort Worth with weapons pod installed. (General Dynamics)

B-58A-10-CF 59-2436 of the 43rd BW. (General Dynamics)

TB-58A 55-0668 Wild Child II *of the 43rd BW was originally flown as a YB/RB-58A in 1958.* (A R Krieger)

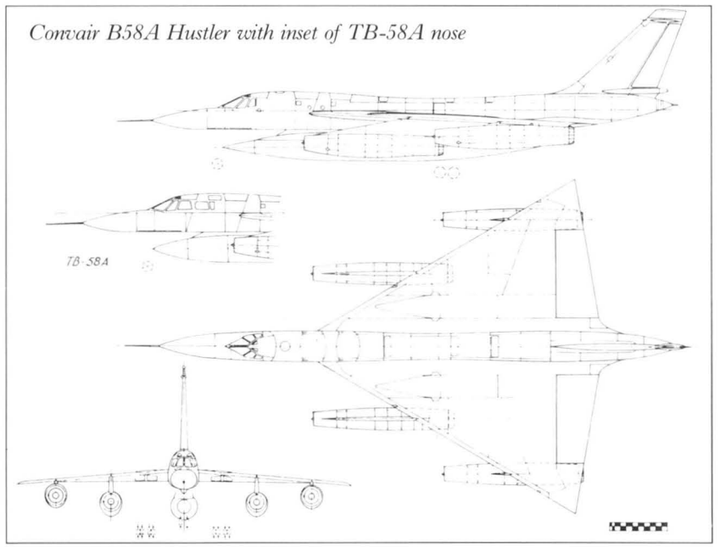
rotational visits were made to Spain, Okinawa, Guam, and Britain.

Because of the B-58's unusual flight, take-off and landing characteristics, a trainer version was approved on 15 September, 1959, and eight trials aircraft (55-661/663, -668, -670/672, 58-1007) were modified as TB-58As with dual controls in the two front cockpits and operational equipment removed; the first (55-670) was initially flown on 10 May, 1960, by Val Prahl.

Despite its uniqueness as the first aircraft capable of sustained supersonic flight, the Hustler received considerable criticism because of its high unit cost (three times that of a B-52G), early high accident rate and its limited unrefuelled range and electronic defensive system. Therefore, to publicise its capabilities, a series of record-breaking flights was made starting in January 1961 with three new speed/payload records. On 10 May, 1961, a B-58A was flown at 1,302mph for 30min to capture the Blériot Trophy and 16 days later, one established a new New York – Paris record (3,626 miles) of 3hr 19min at an average speed of 1,089mph. Unfortunately, on its return to the United States following exhibition at the Paris Air Show, the Hustler crashed after take-off with the loss of the crew that had been responsible for the Blériot Trophy flight. On 5 March, 1962, a round-trip transcontinental speed record was set followed by a climb record to 85,360ft with a 5,000kg (11,023lb) payload. Finally, on 16 October, 1963, a Tokyo – London flight was accomplished at an average speed of 938mph, the last of nineteen official records.

Several B-58 stillborn projects were studied including the B-58B with a lengthened fuselage for more fuel and J79-GE-9s. A prototype (60-1109) was cancelled in July 1959 in favour of B-70 development. The B-58C would have had J58-PWs and two of these engines were to have powered an interceptor version, loosely referred to as the B-58D. Another twin J58 version, for TAC, was unofficially known as the B-58E. There were also a number of proposals to use the Hustler's Mach 2 capability for transport purposes. In 1961, Convair offered a Special Air Mission executive version for Presidential use, and to use a modified external pod to carry up to forty passengers. More realistic was the Model 58-9 with a B-58C wing and a new fuselage seating fifty-two passengers.

Convair B58A Hustler with inset of TB-58A nose



Another eighteen B-58As were destroyed during service and this record contributed to an early withdrawal of the Hustler from service. Other factors were involved with the decision, including the overall cost and problems experienced with the type in service, notwithstanding its engineering accomplishments, the planned introduction of the FB-111, and the widespread operational capability of intercontinental ballistic missiles (ICBMs). And although SAC had specified a low-level mission requirement as early as 1958 as Soviet missile technology improved, and a B-58 had demonstrated a Dallas

The first Convair 880 (Model 22-1) during flight testing. (Convair)

to Edwards AFB flight at Mach .95 and at less than 500ft the following year, its low-level performance was hampered by limited range and a wing structure designed for high-level operations. Thus the first B-58A arrived at Davis-Monthan AFB for storage in November 1969 and by the following January, all remaining aircraft except for a handful of preserved specimens were there. Seven years later, the stripped airframes were disposed of for scrap but six have been preserved at Fort Worth; the USAF Museum; Chanute AFB, Illinois; Grissom AFB, Indiana; Offutt AFB, Nebraska; and Pima County, Tucson, Arizona, respectively. Two more derelict airframes still exist and may also be restored.

B-58A

Four 15,600lb st General Electric J79-GE-5B turbojets with afterburner.

Armament: One 20mm General Electric T-171E3 Vulcan multi-barrel cannon in radar-aimed tail mounting and detachable MB-1C or TCP pod with nuclear weapon.

Span 56ft 10in; length 96ft 9in; height 29ft 11in; wing area 1,542sq ft.

Weight empty 55,560lb (without pod); gross weight 163,000lb.

Maximum speed 1,321mph at 63,150ft; 700mph at sea level; climb 17,830ft/min; 30,000ft/11.2min; service ceiling 63,400ft; combat radius 1,750 miles; ferry range 5,028 miles (15,096US gal fuel capacity with MB-1C pod).

Model 22 Skylark 600 and 880

What was to become a financial disaster for Convair and General Dynamics began in 1954 when the idiosyncratic Howard Hughes requested Convair to design a long-range jet transport for his airline, TWA. Because of Hughes' procrastinations, Boeing and Douglas brought out their 707 and DC-8 models before Convair could finalise a design layout. Still eager to enter the jet transport field, Convair chose the high-speed medium-range market and a preliminary design, the Model 18, similar to the 707 and DC-8, with four underwing Pratt & Whitney J57s, was drawn up by a team led by R C Sebold and R Baylass. Shortly afterwards, two events shaped the future of the commercial venture. Firstly, a proposed link with another General Dynamics-owned manufacturer, Canadair, and Bristol Aircraft in the United Kingdom to produce a Britannia derivative, the Orion-engined Bristol 187, was cancelled. At about the same time, Convair learned that the General Electric J79 (which powered the B-58 Hustler) would be released for civil use. Therefore, in January 1956, Convair decided to go ahead with the programme with 11,200lb st CJ-805-3 engines (J79 equivalents) and formerly announced its Model 22 Skylark 600 in April 1956.

The 35-degree swept-back wing was optimised for the opposite requirements of a 5,000ft field length capability (for up to 1,380 miles range) and a range of 2,300 miles at 600mph. This resulted in a 2,000 ft wing area which in turn offered enough fuel capacity for nonstop transcontinental range. Another requirement, based on forecasts for US domestic traffic, was that the cabin should accommodate eighty first-class passengers in four-abreast seating. Consequently, the fuselage was of a smaller diameter than that of the 707 and DC-8 and only permitted five-abreast seating which resulted in accommodation for 80-124 passengers. Initially a mid-tail position was chosen for the tailplane, later moved to the fuselage.

Initial orders for thirty and ten aircraft were placed by TWA and Delta Air Lines respectively for delivery in 1959 and production started at Plant 1 at San Diego. There was also a name change to Golden Arrow. This reflected the intention of incorporating a gold anodised finish to the exterior skin but was dropped, along with the unusual idea, and the Model 22 was finally called the Convair Jet 880, a figure derived from the cruising speed when converted to feet per second. But further substantial orders were not

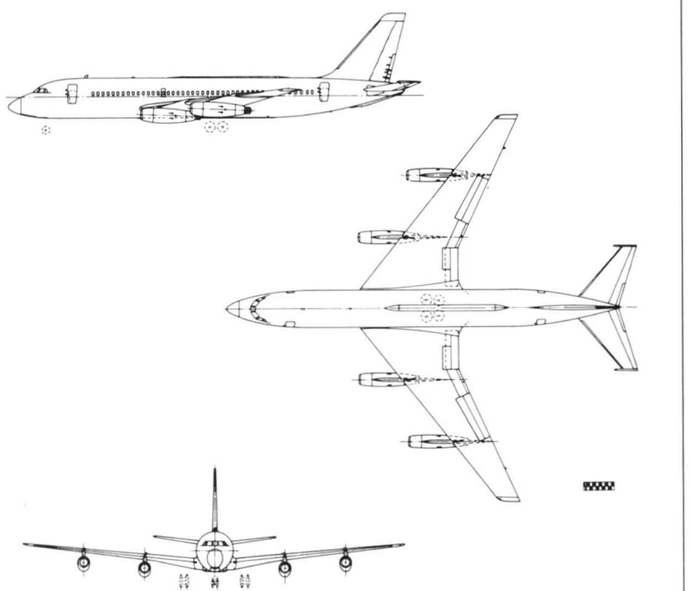
One of the TWA/Hughes Tool Co Convair 880s (Model 22-1) leased to Northeast Airlines. (Larry Milberry)

The largest operator of the Convair 880 was TWA. (Steve Nation)

forthcoming, because of the restrictions on sales to domestic airlines placed on Convair by Hughes and the launch of the Boeing 720 in late 1957. In addition the sales price of the 880 was well below the programme final cost estimates.

Nevertheless, the 880 went ahead and began a 14-month test programme following a first flight of the first aircraft (N801TW msn 1) on 27 January, 1959, in the hands of Don P Germeraad and Phil Prophett. Flight testing went relatively smoothly and confirmed that the 880 could be billed as 'the fastest airliner in the world'. But one potentially disasterous incident during high-speed flutter tests, when most of the vertical fin and most rudder was lost, was averted and a safe landing made at Edwards AFB. The first aircraft with a passenger interior and completed to delivery standards (N8801E msn 4 for Delta) was first flown on 10 August, 1959. Delta was the first to accept an aircraft (N8802E msn 7) and on 10 February, 1960, this was delivered from San Diego to Miami in 3hr 31min, a new transcontinental speed record. Type

Convair Model 22 (880)



One of the last major airlines to fly the Convair 880 was Hong Kong based Cathay Pacific Airways. (Peter R Keating)

Certificate 4A27 was awarded on 1 May, and Delta put the Convair 880 into service on 15 May, between New York and Houston. Subsequently Delta received seventeen aircraft.

To add to Convair's problems, the Hughes Tool Co, parent of TWA, had been unable to secure financing for its order and thirteen 880s were removed from the production line and stored. Finally, after a corporate struggle for control of the airline, the first delivery was made to TWA in January 1961. Eventually, TWA received twenty-seven 880s but four of the original order were leased immediately to Northeast Airlines which went on to operate a total of ten aircraft.

Swissair and SAS (Scandinavian Airlines System) placed a joint order for the Model 31 in 1958 which had additional fuel capacity for international routes and significantly higher operating weights. However, the order was changed to the Model 30 (990) the following year and the 31 was not built.

With only additional orders from Capital Airlines (7), Transcontinental SA (4), and REAL (4), all destined to be cancelled, Convair, faced with mounting losses, announced the Model 22M or 880M (modified) in October 1959 with an order from Capital (transferred from the 880). Intended for shorter ranges and optimised for reduced ground times, the 880M had four leading-edge slats on each wing, a larger fin with power-boosted rudder, provision for pre-loaded baggage containers, a 1,874US gal centre-section fuel tank, strengthened undercarriage for higher weights, General Electric CJ-805-3B engines, new anti-skid, and retractable tailskid. The first 880 was so modified and flown for the first time on 3 October, 1960. Orders were also placed by Alaska Airlines, Civil Air Transport (CAT), Cathay Pacific Airways, the FAA, Japan Air Lines, and VIASA. A certification was awarded on 24 July, 1961, and the first delivery was made to CAT which introduced the type on its *Mandarin Service* from Taipei. A lavishly decorated interior and exterior in traditional Chinese style characterised CAT's aircraft.

After cancellation of the Capital order, the aircraft were leased to Swissair, pending deliveries of Coronados, VIASA and JAL. Another was sold to Cathay Pacific, which started 880 service on 8 April, 1962, and later acquired eight additional aircraft from Alaska, CAT, JAL, Swissair, and VIASA. A total of seventeen Convair 880Ms was built to bring total 880 production to sixty-five, probably less than half that required to break even.

In a belated attempt to enter the lucrative short-haul market, Convair undertook several design studies based upon the 880. The 85-seat Model 60 had a 109ft 5in fuselage and two JT3D or CJ805 turbofans while the Forty-Niner, announced in 1960, had a similar fuselage, four derated CJ805-3Bs, and offered a 4,900ft field length at 135,000lb gross weight.

Although the 880 achieved a good commercial safety record with the scheduled airlines, five aircraft were lost in training accidents. However, the type was popular with pilots and passengers alike. With the sharp increase in fuel prices in the early 1970s, the high burn rate of the CJ-805 engine made the 880 an unattractive proposition and Delta Air Lines retired its fleet at the end of 1973, followed by TWA in June 1974. Overseas, Cathay Pacific withdrew its last aircraft in early 1975 and the Nicaraguan airline LANICA the same year. Most of the aircraft were placed in storage without further use, but a few were operated by cargo airlines, air travel clubs and as executive transports, including one by General Dynamics and another by Elvis Presley.

In 1977, the idle ex-TWA fleet was sold to the North Star Maritime Corp, Los Angeles, but this transaction failed to materialise and sixteen aircraft were acquired by American Jet Industries (later Gulfstream American Corp) the following year for conversion to freighters at Van Nuys, California. The modifications included the addition of a 144in by 81½in forward cargo door and a floor stressed to 150lb/sq ft. Offered in 1979 as the Air-Lifter, eleven were converted but only four actually went into service because the high operating costs offset the low acquisition price. In an effort to make the aircraft more attractive, Convair studied the possibility of replacing the four CJ-805s with two derated CF6-6 turbofans but this remained a study. In 1985, all Gulfstream American's used aircraft fleet (which included twenty-one 880s) were sold to Charlotte Aerospace, North Carolina, in a deal believed intended for China. However, none were delivered and most of the 880s, including eight with the freight door, remain at Mojave, California.

The Navy acquired one 880 (msn 55M) in 1980 for use as a flight refuelling tanker for the F-18 programme. A hose drum unit from a Douglas KA-3D was installed by Flight Systems Inc, at Mojave, along with new fuel, hydraulic, and electrical systems. Designated UC-880 (BuA 161572) and operated by FSI, it remains in use by the NATC, Patuxent River, the sole active Convair 880.

Model 22M

Four 11,650lb st General Electric CJ- 805-3B turbojets.

Accommodation: 80-130 passengers.

Span 120ft 0in; length 129ft 4in; height 36ft 4in; wing area 2,000sq ft.

Weight empty 93,000lb; gross weight 193,500lb.

Maximum speed 586.5mph at 22,500ft (Mach 0.88); cruising speed 556mph at 35,000ft; ceiling 41,000ft; range 4,050 miles (12,650US gal fuel capacity).

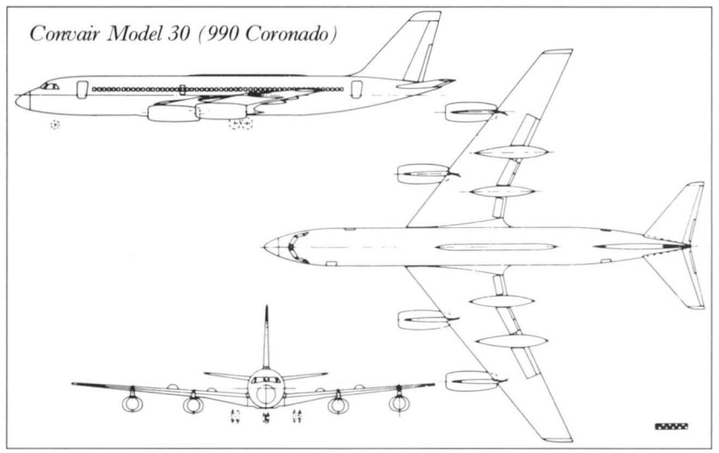
Launch customer for the Convair 990 was American Airlines. (Jay L Sherlock)

Model 30 600 and 990 Coronado

In an attempt to boost the order book for the Model 22 and provide a competitor for the Boeing 720, Convair offered to American Airlines what was simply termed a modification of the 880. General Electric had developed a revolutionary turbofan version of its CJ-805 engine, the -21 (later -23), which offered greater take-off thrust and lowered fuel consumption during cruise, the latter then more of an advantage for greater range than lower cost. In order to avoid a redesign of the basic engine, General Electric chose to mount the fan aft of the engine. To take advantage of the new engine, the fuselage was lengthened by 10ft, for up to 121 passengers. Improved field performance was achieved through the use of larger flaps and leading-edge slats. Wing area was increased over that of the 880, but the wing was thinner to increase the maximum cruising speed to Mach 0.91 or 635mph. This in turn created problems with the supersonic airflow over the wings which separated at the trailing edge causing additional drag. With the help of NACA, this problem was solved through the use of two anti-shock bodies, called speed-pods, which extended back from each

The first Model 30 after conversion to 990A standard. (Convair)

Swissair used the name Coronado for its 990 (Model 30-6) fleet. It was adopted by other operators. (John Wegg)



wing. The pods were also used to store an extra 1,240US gal of fuel. In addition, an overall strengthening of the structure was necessary and a larger fin was installed.

In this form the Model 30 was launched in July 1958, before the 880 had even rolled out, with an order for twenty-five plus twenty-five options from American Airlines. Deliveries were scheduled to begin in March 1961. Because of Hughes' insistence that any new model should not overshadow the 880, the type was called the Convair 600 (880ft/sec = 600 mph). An order from the Swissair/SAS consortium for 880s was switched to nine over-water 600s (Model 30-6) with an extra 556US gal fuel capacity, called Coronado by these airlines. An order for three Model 30-8s was placed by REAL of Brazil (taken over by VARIG) and Howard Hughes also ordered thirteen aircraft and, in November 1960, allowed Convair to redesignate the aircraft, and the 600 became the Convair 990.

Convair chose not to build a prototype in order to maintain a time advantage with the fan-jet engine over Pratt & Whitney and Boeing, and the 990 was built on the same assembly line as the 880 at San Diego. On 24 January, 1961, Don P Germeraad made the first flight with the initial production aircraft (N5601), a Model 30-5 destined for American Airlines. Almost immediately, aerodynamic problems surfaced. Wing vibrations were different from those predicted and drag far higher which prevented the 990 from reaching its promised cruising speed and range. The engineering changes to aircraft on the production line were extensive, the engines were realigned 28in to the rear with pylon modifications, the engine nacelle shape was revised, and leading-edge slats were added between the fuselage and inboard engines. In this standard, the aircraft were redesignated 990As (Model 30A) and six aircraft were used for flight tests, plus one additional airframe for static tests.

Meanwhile, delivery delays and shortfall in performance led to a revised contract with American and in the event, only twenty aircraft were finally delivered. Cancellations also came from Hughes and as a result of the design problems and Pratt & Whitney's development of the fan-jet JT-3D for the competitive Boeing 720B, production ended after thirty-seven aircraft. Type Certificate 4A30 was awarded for the 990 on 15 December, 1961, and the first delivery made to American on 8 January, followed by the inaugural service on 18 March, 1962. Swissair had started service with the Coronado on Far East routes on 9 March. Certification of the 990A was not received until 10 October, 1962. Therefore, American and Swissair were forced to operate the early aircraft at lower speeds.

The other five aircraft of the American order were built and sold to Garuda (three), APSA of Costa Rica (one), and Garrett AiResearch. The first aircraft was refurbished and sold to NASA for use as an airborne celestial research laboratory. Swissair eventually operated eight (the SAS order was cancelled and two aircraft were leased from Swissair, in turn leased to Thai Airways International).

American started to dispose of its 990A fleet in 1965 as more fuel efficient aircraft became available and most were purchased by charter airlines. Modern Air Transport acquired ten (including two ex-VARIG) and increased seating capacity to 149 and installed an APU. Longest operator of the 990A was the Spanish airline Spantax, which acquired fourteen aircraft and kept them in service, albeit in dwindling numbers, until 1987. Two were lost in accidents and a third narrowly escaped the same fate when it lost 18ft of wing in an inflight collision with a DC-9 over France. The latter crashed, but the 990A made a safe landing.

Many Swissair Coronados were leased to other airlines, including Air Afrique, Air Ceylon, Balair, El Al, and Ghana Airways. Alaska Airlines acquired one aircraft (ex-VARIG) and others were purchased second-hand by Lebanese International (LIA) and Middle East Airlines. Northeast leased one 990A, as did Air France which used it for Paris–London services in 1967. The last major US operator was the travel club Denver Ports of Call, which retired the type in 1974. In January 1988, one of the ex-Ports of Call aircraft, previously in storage, was delivered to Ciskei International Airways for Bisho–Johannesburg service but no revenue flights took place.

Several Convair 990As remain in storage, one has been converted into a restaurant in Colorado (now closed), and Swissair donated one of its popular Coronados to the Transport Museum in Lucerne.

Model 30A Coronado (990A).

Four 16,100lb st General Electric CJ805-23B turbofans.

Accommodation: 90-149 passengers.

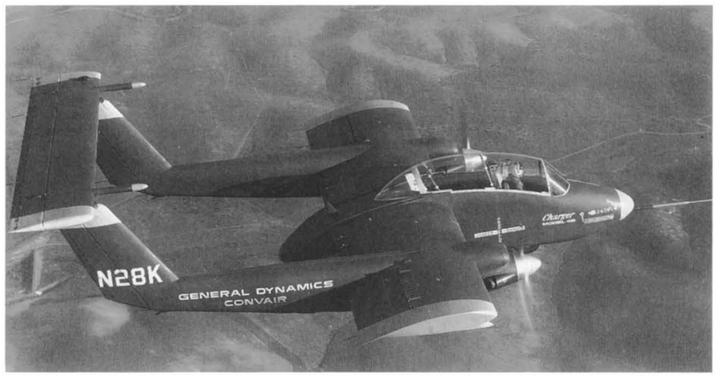
Span 120ft 0in; length 139ft 5in; height 39ft 6in; wing area 2,250sq ft.

Weight empty 120,560lb; gross weight 255,000lb.

Maximum cruising speed 625mph at 21,200ft (Mach 0.91); typical cruising speed 570mph at 35,000ft; ceiling 41,000ft; range 4,810 miles (15,708US gal fuel capacity).

Model 48 Charger

The concept of an inexpensive ground attack aircraft to supplement high-speed combat types was first officially proposed by two Marine Corps officers in 1960 and became known as the L2VMA (Light-Light Marine Attack Aircraft) and was a twin-boom layout. The following year, a transport role and greater weapons capability was added and design studies were coordinated by the Navy until mid-1963 when a Counter-insurgency (COIN) group was formed and a specification finalised in September for a Light Armed Reconnaissance Aircraft (LARA) and issued to all US manufacturers. The requirement was for a twin-propeller-turbine, tandem two-seat aircraft capable of operating from rough fields, small roads, and carriers without special equipment with four 500lb bombs and four internal 7.62mm guns for close air support. For alternative roles, it had to carry 2,000lb of cargo, six paratroopers or stretchers and operate as a float equipped amphibian.



Last of the Convair line, the Model 48 Charger. (Convair)

Nine manufacturers submitted proposals including the Convair Division of General Dynamics which had studied the concept since 1958. Not waiting for the result of the Navy evaluation, Convair went ahead and built a prototype Model 48 Charger as a private venture. Powered by two Pratt & Whitney T74 propeller-turbines driving 9ft opposite-rotating three-blade propellers, the Charger was tailored to the specification and was of conventional aluminium construction except for glassfibre nose, rear fuselage, and wingtip fairings. Many components including the undercarriage, whose main legs retracted into the booms, engine power sections, self-sealing fuel cells, wing flaps (which doubled as ailerons outboard of the booms), fins, and rudders were all interchangeable right and left, simplifying spares problems and reducing initial cost. Slow speed control was effected by spoilers linked to the ailerons and Krueger-type leading-edge flaps, and the tailplane was all-moving. Four machine-guns were pod-mounted in pairs each side of the fuselage and five external store hardpoints could carry up to 2,000lb of ordnance or other equipment. Two large amphibious single-step floats could be carried on pylons beneath the booms.

Just 35 weeks after the design had been finalised and submitted in March 1964, the prototype (N28K) was first flown by John W Knebel on 25 November from San Diego to NAS North Island. Meanwhile, in August 1964, the Navy announced the North American NA-300 (OV-10 Bronco) as winner of the design competition.

But because of protests from the Army and Marine Corps, who favoured the Charger, Convair received a 100 hour flight test contract. STOL trials were undertaken in May 1965, and the Charger demonstrated a 485ft take-off over a 50ft obstacle with a normal payload. Preliminary evaluation, completed in autumn 1965, led to ventral and dorsal fins being added to the tail booms to improve low-speed directional control and a 2ft $7^{1}/_{4}$ in increase in wingspan. Production aircraft were to have a fuselage deepened by 7in and lengthened by 2ft to provide space for full dual control in the second cockpit

The eventual result of the LARA contest seemed to rest on a fly-off between the NA-300 and Charger but on 19 October, 1965, the latter was destroyed after its Navy pilot ejected successfully from an altitude of 100ft. Although Convair publicly stated that the accident would not affect the programme, all further work was abandoned in early 1966, and no other complete aircraft of any type were built by Convair.

Two 650shp United Aircraft of Canada (Pratt & Whitney) T74-CP-8/10 propeller-turbines (-8 on port side, -10 on starboard side).

Armament: Four 7.62mm M60 machine-guns pod-mounted in pairs on each side of centre fuselage. Attachments under fuselage and each wing for up to 2,000lb of bombs, rocket pods, flare dispensers and missiles.

Span 27ft 6in (later 30ft $1^{1}/_{4}$ in); length 34ft 10in; height 13ft 7in; wing area 192 sq ft (initial), 216sq ft (revised).

Weight empty 4,457lb; gross weight 10,460lb.

Maximum speed 319 mph at sea level; service ceiling 21,300ft; ferry range 3,000 miles.

Joe Gwinn's first Aircar at the National Air Races, Cleveland, 1937. (San Diego Aerospace Museum)

Gwinn Model 1 Aircar

Following Consolidated's move to San Diego in 1935, designer Joe Marr Gwinn Jn, always an innovative engineer, patented rights to an 'aircar' design that he had previously offered, without success, to Reuben Fleet. Leaving Consolidated, he formed the Gwinn Aircar Company in Buffalo on 3 September, 1935 to produce it. The Model 1 Aircar was an unconventional side-by-side two-seat cabin biplane with a tricycle undercarriage and incorporated many parts from a 1935 Oldsmobile. The fuselage was an all-metal monocoque structure which included the vertical fin, fitted with a trim tab (but no rudder) for directional control. A large door on either side with an exterior step allowed for easy access to the cabin. The symmetrical wings, braced by 'N' struts on each side, were of NACA 4418 aerofoil and were built up of spruce spars with aluminium ribs. The leading edges were covered with dural metal sheet, the remainder was fabric covered. Construction took 21 months, from 15 September, 1935, to 11 June, 1937, and was undertaken by Stanley Dybowski, a tool and metal worker. First displayed at the National Air Races held at Cleveland in September 1937 by Richard K Bennett, the Aircar (X1271 msn 501) was powered by a 90hp Pobjoy Niagara II seven-cylinder air-cooled radial engine driving a large, four-bladed Fahlin wooden propeller.

Envisioned as an 'everyman's airplane', the Aircar was a two-control aircraft with an automobile-type steering wheel used for turns in the air and for steering the nosewheel on the ground. A floor-mounted accelerator pedal acted as a throttle on the ground and a dash-mounted throttle was used in the air. Two other floor-mounted pedals operated the air brakes (wing flaps) and the main wheel brakes.The elevators only had a total movement of $8^1/_2$ degrees and to take-off, the aircraft was driven along the ground until sufficient speed was reached (around 55mph) then the foot pedal-operated flaps were selected and an instantaneous zoom climb made. To land, a level approach was made with flaps selected and when power was reduced, the Aircar settled into a glide and even touchdown. Gwinn claimed that this rudderless design was safe for everyone and would not stall or spin.The aircraft's potential was recognised by well-known racing pilot Frank M Hawks who became vice-president and sales manager for Gwinn. Nancy H Love, another well-known pilot with Inter City Airlines, Boston, Massachusetts, received a rating of competency in the Aircar in April 1938 and also gave demonstrations.

A second Aircar, the Model 2 (X16921 msn 502) with a 130hp Pobjoy Niagara V–7 engine was built and flown in 1938. Engine problems led to the temporary installation of an 85hp Niagara and on 23 August, 1938, Hawks flew the second Aircar to the estate of Edmund Rogers at East Aurora, New York, to meet with a group of potential investors. J Hazard Campbell took a demonstration flight with Hawks, but after take-off from a polo field the Aircar hit power lines and crashed, killing the occupants. That same day, a certificate of airworthiness for the Aircar was denied (ATC 682 had been pending) and Gwinn, affected by the tragedy, suspended all plans for production.

The first Aircar was sold to Dybowski in June 1942, but reverted to Gwinn in February 1945. Fitted with an 88hp Niagara III engine, the Aircar was rebuilt by May and re-licensed (NC1271) as a single-seater for evaluation flights by the Stout Research Division of Convair. Flights from Stinson Field, Michigan, were made by Donald R Suchner. Reports indicate that the Aircar was subsequently taken to San Diego and later donated to a school.

Although not a Consolidated design, the basic arrangement was adopted for two experimental 'real' aircars, both monoplanes, the Convair Model 103 and 111.

Model 1

Span 24ft 0in; length 16ft 3in; height 6ft 10in; wing area 169.4sq ft.

Weight empty 1,099lb; gross weight 1,532lb.

Maximum speed 118mph; cruising speed 103mph; initial climb 450ft/min; service ceiling 10,000ft; range 495 miles (25US gal fuel capacity).

Convair Selected Projects

XA-44/XB-53

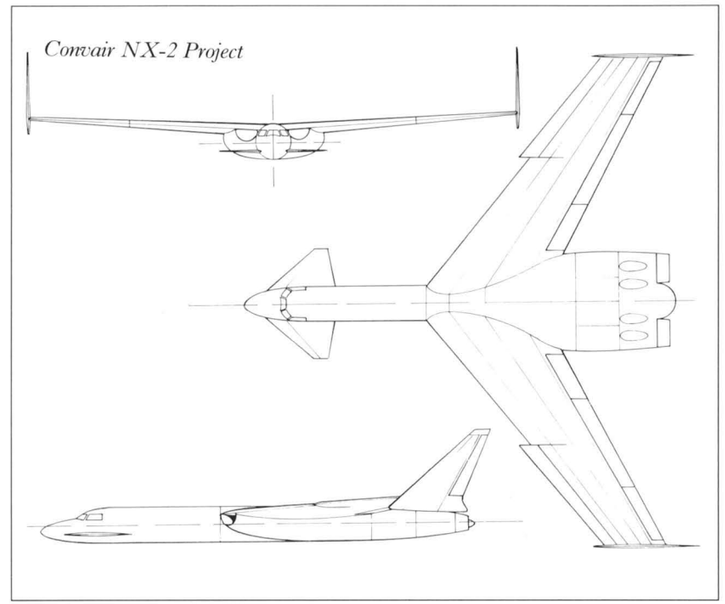
Tactical bomber with three 4,000lb st General Electric J35s buried in the fuselage and fed by two lateral air intakes, 30-degree forward-swept wing, redesignated XB-53 in 1948. Two prototypes (45-59583/59584) ordered but cancelled before airframes were completed.

XP-92

Ramjet interceptor, initially with swept wing then modified with 60-degree delta, designed by Vultee Field Division. Project transferred to San Diego in 1947 and cancelled 1948. A flying test-bed for the concept was designated XF-92A (qv).

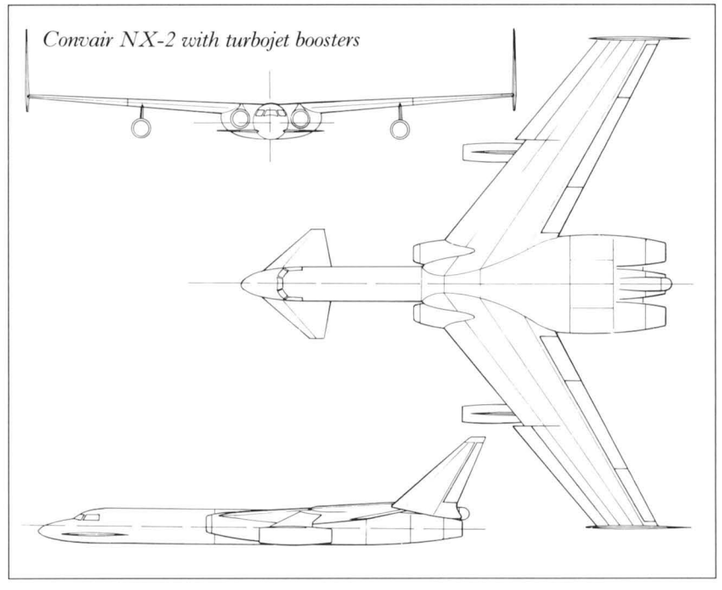
X-6

In February 1951, the USAF awarded a contract for the conversion of two B-36Hs to X-6s powered by General Electric P-1 nuclear turbojet engines to study the possibility of building a prototype nuclear-powered bomber. Only preliminary design work took place before the nuclear power programme was reduced in scope and the X-6s were cancelled in 1953. However, one conversion of a B-36H to carry a small reactor did take place (*see* NB-36H) and undertook flight tests to evaluate the effects of radiation on the aircraft.



NX-2

A Fort Worth project from 1951, the NX-2 designation covered a nuclear-powered bomber which subsequently was tailored around requirement WS-125A, dated 1954. Convair teamed with General Electric, which proposed the 55,000lb st X211 (J87) engine consisting of two gas-turbines coupled with a single nuclear reactor source. Conventional turbojets were to be carried on the wings. Chemically-fuelled afterburners were also envisaged but a major drawback was the radioactive exhaust of the engine.



In 1956, the project was abandoned as unrealistic but a contract was received for a continuous airborne alert missile-launching (CAMAL) aircraft with low-level penetration ability. Drawings were publicised showing a tail-first design, with fins and rudders on each wingtip. The suggested primary powerplant in the fuselage was a General Electric direct air cycle engine, supplemented with turbojets on the wings.

This, in turn, was cancelled in 1960 but Convair started work on two subsonic NX-2s to flight test both General Electric and Pratt & Whitney engines. A first flight was planned for 1965, but the Aircraft Nuclear Propulsion programme, along with the NX-2s, was cancelled in 1961.

Duck

The USAF allocated twelve serials (55-3490/3501) for this vehicle, details of which have not been released.

duction was to have been at Fort Worth but all were cancelled.

Submersible ASW

A submersible ASW flying-boat for the US Navy, six-month study 1964/65 under Bureau of Naval Weapons. Underwater, it was to be powered by electric motors and batteries.

Stilt

In 1964, Convair used a Martin Mariner (9148) fitted with vertical floats designed by Convair to provide a stable ASW platform in rough seas. Called the Stilt programme, Convair had earlier used the technique for advanced flying-boat studies, primarily towing basin and engineering tests.

Model 15

Four-engined Dart Convair-Liner with stretched fuselage.

Model 21

ASW proposal similar to winner Lockheed S-3.

Model 24

Three 2,000hp Wright Turbocompound-powered ASW flying-boat, two ordered 1956 as XP6Y-1 (BuA 147206/147207) but cancelled.

Model 38 Convair 640

In 1963, a design for a short-haul jet with two 6,450lb st Rolls-Royce RB.185 engines was finalised with a projected first flight in November 1965. Seating forty-eight passengers in a four-abreast layout, the T-tailed project had a 98ft span wing with 15 degrees sweepback; gross weight of 48,500lb; and length of 84ft 6in. Had it been built, the Model 38 would have been similar to, and competed with, the Fokker F.28. The designation 640 was applied to the Dart-powered conversions of the 340/440 in 1966.

Model 44

Navy fighter similar to Grumman F-14.

Model 49

Ducted rotor VTOL with three Lycoming LTC4B-11 propeller-turbines studied 1964.

Convair-Liner Production

(Model number follows msn, only first customer listed, pre-delivery registrations not shown.)

msn			
1	240-9	NX90849	prototype
2	240-0	N94200	American Airlines
3	240-1	N8401H	Western Air Lines
4–6	240-0	N94201/94203	American Airlines
7	240-1	N8402H	Western Air Lines
8	240-0	N94204	American Airlines
9	240-2	N90655	Pan American Airways
10–11	240-0	N94205/94206	American Airlines
12	240-1	N8403H	Western Air Lines
13	240-0	N94207	American Airlines
14	240-2	N90656	Pan American Airways
15–16	240-0	N94208/94209	American Airlines
17	240-1	N8404H	Western Air Lines
18	240-0	N94210	American Airlines
19	240-2	N90657	Pan American Airways
20–21	240-0	N94211/94212	American Airlines
22	240-1	N8405H	Western Air Lines
23	240-0	N94213	American Airlines
24	240-2	N90658	Pan American Airways
25–26	240-0	N94214/94215	American Airlines
27	240-1	N8406H	Western Air Lines
28	240-0	N94216	American Airlines
29	240-15	N24927	Convair
30–31	240-0	N94217/94218	American Airlines
32	240-5	VH-TAO	Trans-Australia Airlines
33	240-0	N94219	American Airlines
34	240-2	N90659	Pan American Airways
35	240-6	LV-ADM	FAMA/Aerolineas Argentinas
36	240-0	N94220	American Airlines
37	240-1	N8407H	Western Air Lines
38	240-8	XB-DOX	Jorge Pasquel
39	240-2	N90660	Pan American Airways
40–41	240-0	N94221/94222	American Airlines
42	240-5	VH-TAP	Trans-Australia Air Lines
43	240-0	N94223	American Airlines
44	240-2	N90661	Pan American Airways
45–46	240-0	N94224/94225	American Airlines
47	240-2	N8408H	Western Airlines
48	240-0	N94226	American Airlines
49	240-2	N90662	Pan American Airways
50	240-6	LV-ADN	Aerolineas Argentinas
51	240-0	N94227	American Airlines
52	240-7	AP-AEH	Orient Airways
53–54	240-0	N94228/94229	American Airlines
55	240-2	N90663	Pan American Airways
56–57	240-0	N94230/94231	American Airlines
58	240-1	N8409H	Western Air Lines
59	240-2	N90664	Pan American Airways
60	240-0	N94232	American Airlines
61	240-4	PH-TEA	KLM
62	240-6	LV-ADO	Aerolineas Argentinas
63	240-0	N94233	American Airlines
64	240-5	VH-TAQ	Trans-Australia Airlines
65	240-2	N90665	Pan American Airways
66	240-0	N94234	American Airlines
67	240-2	N90666	Pan American Airways
68–69	240-0	N94235/94236	American Airlines
70	240-1	N8410H	Western Air Lines
71	240-2	N90667	Pan American Airways
72	240-6	LV-ADP	Aerolineas Argentinas
73	240-3	N90844	Continental Airlines
74	240-0	N94237	American Airlines

75	240-7	AP-AEF	Orient Airways	1	340-30	N3401	prototype
76	240-0	N94238	American Airlines	2–5	340-31	N73102/73105	United Air Lines
77	240-6	LV-ADQ	Aerolineas Argentinas	6	340-32	N3406	Braniff International Airways
78	240-4	PH-TEB	KLM				
79	240-4	PH-TEC	KLM	7–8	340-31	N73106/73107	United Air Lines
80–81	240-0	N94239/94240	American Airlines	9–10	340-33	N726A/727A	Aramco
82	240-7	AP-AEG	Orient Airways	11–12	340-31	N73108/73109	United Air Lines
83–84	240-2	N90668/90669	Pan American Airways	13	340-34	N1621	Texaco
				14–19	340-31	N73110/73115	United Air Lines
85–89	240-0	N94241/94245	American Airlines	20–21	340-32	N3407/3408	Braniff International Airways
90–91	240-2	N90670/90671	Pan American Airways	22	340-35	N90852	Continental Airlines
92–93	240-5	VH-TAR/TAS	Trans-Australia Airlines	23	340-31	N73116	United Air Lines
				24	340-36	N5506K	Hawaiian Airlines
94–97	240-3	N90845/90849	Continental Airlines	25	340-31	N73117	United Air Lines
98–99	240-2	N90672/90673	Pan American Airways	26–27	340-32	N3409/3410	Braniff International Airways
100	240-14	XT-600	Central Air Transport	28–29	340-31	N73118/73119	United Air Lines
101	240-10	N90860	Harold S Vanderbilt	30	340-38	N4801C	Delta Air Lines
102	240-0	N94246	American Airlines	31–32	340-32	N3411/3412	Braniff International Airways
103	240-2	N90674	Pan American Airways	33	340-36	N5507K	Hawaiian Airlines
104–109	240-0	N94247/94252	American Airlines	34–35	340-31	N73120/73121	United Air Lines
110–122	240-4	PH-TED/TEF	KLM	36	340-37	N13302	Pratt & Whitney
113	240-11	HB-IRP	Swissair	37	340-32	N3413	Braniff International Airways
114–122	240-0	N94253/94261	American Airlines				
123–125	240-4	PH-TEG/TEI	KLM	38–39	340-38	N4802C/4803C	Delta Air Lines
126–127	240-14	XT-602/604	Central Air Transport	40	340-40	OH-LRA	Finnair
128	240-12	OO-AWO	SABENA	41–43	340-31	N73122/73124	United Air Lines
129–131	240-14	XT-606/608/610	Central Air Transport	44	340-35	N90853	Continental Airlines
132–134	240-11	HB-IRS/IRT/IRV	Swissair	45–48	340-32	N3414/3417	Braniff International Airways
135–139	240-0	N94262/94266	American Airlines				
140	240-13	N91237	Northeast Airlines	49–50	340-35	N90854/90855	Continental Airlines
141–142	240-0	N94267/94268	American Airlines	51	340-38	N4804C	Delta Air Lines
143–145	240-4	PH-TEK/TEM	KLM	52–54	340-31	N73125/73127	United Air Lines
146–151	240-0	N94269/94274	American Airlines	55	340-42	PI-C340	Philippine Air Lines
152	240-17	49-1913	USAF (T-29A)	56–57	340-31	N73128/73129	United Air Lines
153–157	240-12	OO-AWP/AWT	SABENA	58	340-36	N5508K	Hawaiian Airlines
158–161	240-13	N91238/91241	Northeast Airlines	59	340-31	N73130	United Air Lines
162	240-13	N91241(2)	Northeast Airlines	60	340-38	N4805C	Delta Air Lines
163	240-26	N94278	American Airlines	61–62	340-32	N3418/3419	Braniff International Airways
164–166	240-26	N94275/94277	American Airlines				
167	240-24	N300K	Ford Motor Co	63	340-41		Northeast Airlines, NTU, to I-DOGI Alitalia
168	240-25	ET-T-20	Ethiopian Airlines				
169	240-17	49-1910	USAF (T-29A)				
170	240-25	ET-T-21	Ethiopian Airlines	64–65	340-32	N3420/3421	Braniff International Airways
171–175	240-23	PK-GCA/GCE	Garuda Indonesian Airways	66	340-36	N5509K	Hawaiian Airlines
176–178	240-23	PK-GCG/GCI	Garuda Indonesian Airways	67	340-35	N90856	Continental Airlines
				68-70	340-31	N73131/73133	United Air Lines
179–224	240-17	49-1911/1912, 49-1914/1945, 50-183/194	USAF (T-29A)	71	340-32	N3422	Braniff International Airways
				72	340-31	N73134	United Air Lines
225–329	240-27	51-3797/3816, 51-5114/5172, 51-7892/7917	USAF (T-29B)	73	340-40	OH-LRB	Finnair
				74	340-38	N4806C	Delta Air Lines
				75	340-40	OH-LRC	Finnair
330–448	240-27	52-1091/1175, 53-3461/3494	USAF (T-29C)	76	340-36	N5510K	Hawaiian Airlines
				77–78	340-32	N3423/3424	Braniff International Airways
52-1/92	240-52	52-1176/1185, 52-5812/5836, 52-9976/9980, 53-3495/3546	USAF (T-29D)	79	340-42	PI-C341	Philippine Air Lines
				80–81	340-32	N3425/3426	Braniff International Airways
53-1/-26	240-53	52-5781/5806	USAF (C-131A)	82–83	340-35	N90857/90858	Continental Airlines
				84	340-38	N4807C	Delta Air Lines
				85–86	340-31	N73135/73136	United Air Lines
				87	340-41		Northeast Airlines NTU, to I-DOGO Alitalia

(Total 566)

88–89	340-31	N73137/73138	United Air Lines
90	340-32	N3427	Braniff International Airways
91	340-36	N5511K/53-7886	(YC-131C)
92	340-38	N4808C	Delta Air Lines
93–94	340-31	N73139/73140	United Air Lines
95	340-38	N4809C	Delta Air Lines
96	340-42A	N8420H	Union Producing Co (rebuilt as 440 msn 327A)
97	340-42	PI-C342	Philippine Air Lines
98	340-31	N73141	United Air Lines
99	340-32	N3428	Braniff International Airways
100–101	340-38	N4810C/4811C	Delta Air Lines
102	340-41		Northeast NTU, to I-DOGU Alitalia
103	340-41		Northeast NTU, to N730RR Chicago Tribune
104	340-48	PH-TGD	KLM
105–107	340-38	N4812C/4814C	Delta Air Lines
108	340-47	N8412H	National Airlines
109–111	340-32	N3429/3431	Braniff International Airways
112	340-41		Northeast NTU, to I-DUGA Alitalia
113-114	340-48	PH-TGE/TGF	KLM
115–116	340-47	N8413H/8414H	National Airlines
117–118	340-38	N4815C/4816C	Delta Air Lines
119–122	340-48	PJ-CVA/ PH-TGG/ PH-TGI	KLM
123–124	340-38	N4817C/4818C	Delta Air Lines
125–126	340-47	N8415H/8416H	National Airlines
127	340–31	N73142	United Air Lines
128–130	340-47	N8417H/8419H	National Airlines
131	340-64	53-7887	USAF (YC-131C)
132	340-31	N73143	United Air Lines
133–135	340-48	PJ-CVC/CVE/ CVB	KLM
136–137	340-54	N11136/11137	Pan American (Méxicana)
138	340-38	N4819C	Delta Air Lines
139	340-57	YV-C-EVA	Avensa
140	340-66	140378	USN (R4Y-1Z)
141	340-31	N73144	United Air Lines
142	340-51	XA-KIL	Aeronaves de México
143–144	340-48	PJ-CVM/CVS	KLM
145	340-31	N73145	United Air Lines
146	340-51	XA-KIM	Aeronaves de México
147	340-63	N7600	Union Oil of California
148	340-68A		Lufthansa NTU, to N40N Union Carbide
149	340-57	YV-C-EVE	Avensa
150–151	340-54	N11150/11151	Pan American (Méxicana)
152	340-38	N4820C	Delta Air Lines
153	340-42C		PAL NTU, to G-ANVP Napier
154	340-31	N73146	United Air Lines
155	340-42B		PAL NTU, to N130B American Can Co
156	340-51	XA-KIN	Aeronaves de México
157	340-31	N73147	United Air Lines
158	340-51	XA-KOU	Aeronaves de México
159	340-59	PP-CDW	Cruzeiro do Sul
160	340-54	N11160	Pan American (LACSA)
161	340-31	N73148	United Air Lines
162	340-58	YU-ADA	JAT
163	340-31	N73149	United Air Lines
164	340-57	YV-C-EVI	AVENSA
165	340-49	PK-CGK	Garuda Indonesian Airways
166–167	340-59	PP-CDY/CDZ	Cruzeiro do Sul
168–170	340-31	N73150/73152	United Air Lines
171	340-51A		Jorge Pasquel NTU, to VH-BZE Ansett Airways
172	340-49	PK-GCL	Garuda Indonesian Airways
173	340-48	PH-CGA	KLM
174	340-68B		Lufthansa NTU, to HZ-AAT Saudi Arabian Airlines
175	340-59	PP-CEA	Cruzeiro do Sul
176	340-54	N11176	Pan American (LACSA)
177–178	340-58	YU-ADB/ADC	JAT
179–180	340-31	N73153/73154	United Air Lines
181	340-49	PK-GCM	Garuda Indonesian Airways
182	340-68B		Lufthansa NTU, to HZ-AAU Saudi Arabian Airlines
183	340-68		Lufthansa NTU, to 54-2805 USAF (VC-131D)
184	340-48	PH-CGB	KLM
185-186	340-31	N73155/73156	United Air Lines
187–188	340-49	PK-GCN/GCO	Garuda Indonesian Airways
189	340-62	PP-YRA	REAL
190	340-68B		Lufthansa NTU, to HZ-AAV Saudi Arabian Airlines
191	340-62	PP-YRB	REAL
192–194	340-49	PK-GCP/GCS	Garuda Indonesian Airways
195–196	340-62	PP-YRC/YRD	REAL
197	340-68B		Lufthansa NTU, to SA-R-5 Saudi Arabian Govt
198	340-68	D-ACAD	Lufthansa
199–200	340-62	PP-YRE/YRF	REAL
201	340-79	54-2806	USAF (C-131D)
202	340-79	N8431H	Convair 440 development test
203	340-79	54-2807	USAF (C-131D)
204–205	340-67	54-2808/2809	USAF (VC-131D)
206–207	340-79	55-290/54-2810	USAF (C-131D)
208–209	340-67	54-2811/2812	USAF (VC-131D)
210–211	340-68	D-ACEF/ACIG	Lufthansa
212	340-79	55-291	USAF (C-131D)
213	340-68	D-ACOH	Lufthansa
214	340-69	N76Y	Continental Oil
215	340-79	54-2813	USAF (C-131D)
216–217	340-67	54-2814/2815	USAF (VC-131D)
218–219	340-68B	HZ-AAY/AAZ	Saudi Arabian Airlines
220–221	340-67	58-2816/2817	USAF (VC-131D)
222	340-68B	HZ-ABA	Saudi Arabian Ailines
223–224	340-79	55-295/296	USAF (C-131D)

225–226	340-67	54-2818/2819	USAF (VC-131D)
227	340-68B	HZ-ABB	Saudi Arabian Ailines
228	340-67	54-2820	USAF (VC-131D)
229	340-79	55-298	USAF (C-131D)
230	340-68B	HZ-ABC	Saudi Arabian Ailines
231–232	340-67	54-2821/2822	USAF (VC-131D)
233	340-79	55-300	USAF (C-131D)
234–235	340-67	54-2823/5824	USAF (VC-131D)
236–237	340-62		REAL NTU, to YV-C-AVH/AVT Avensa
238	340-67	54-2825	USAF (VC-131D)
239	340-68B	HZ-ABD	Saudi-Arabian Airlines
240–275	340-70	53-7788/7823	USAF (C-131B)
276–311	340-71	140993/141028	USN (R4Y-1)
(Total 311)			
312	440-77	N8424H	prototype
313	440-78	A96-313	RAAF
314	440-35	N90860	Continental Airlines
315-316	440-79	55-292/293	USAF (C-131D)
317	440-40	OH-LRD	Finnair
318–319	440-35	N90861/90862	Continental Airlines
320	440-75	LN-KLB	SAS
321–322	440-79	55-294/297	USAF (C-131D)
323–325	440-75	LN-KLD/KLE/ OY-KPA	SAS
326	440-79	55-299	USAF (C-131D)
327	440-11	HB-IMB	Swissair
327A	440-42A	N8444H	Union Producing (built from 240 msn 96)
328	440-12	OO-SCJ	SABENA
329	440-79	55-301	USAF (C-131D)
330	440-12	OO-SCK	SABENA
331	440-75	OY-KPB	SAS
332	440-11	HB-IMC	Swissair
333	440-62	PP-YRG	REAL
334	440-47	N2041	National Airlines
335	440-11	HB-IMB	Swissair
336	440-12	OO-SCL	SABENA
337-342	440-72	55-4750/4755	USAF (C-131E)
343	440-72	N105	CAA
344-346	440-72	55-4757/4759	USAF (C-131E)
347–348	440-47	N2042/2043	National Airlines
349	440-62	PP-YRH	REAL
350–351	440-75	OY-KPC/ SE-BSO	SAS
352	440-47	N2044	National Airlines
353	440-78	A96-353	RAAF
354	440-12	OO-SCM	SABENA
355	440-11	HB-IMF	Swissair
356–358	440-75	SE-BSP/BSS	SAS
359	440-38	N4821C	Delta Air Lines
360	440-11	HB-IMG	Swissair
361	440-12	OO-SCN	SABENA
362	440-75	SE-BST	SAS
363–365	440-11	HB-IMH/IMK/ IML	Swissair
366–368	440-12	OO-SCO/SCQ	SABENA
369–370	440-47	N2045/2046	National Airlines
371	440-62	PP-AQA	REAL
372	440-90	N440J	General Dynamics
373–374	440-12	OO-SCR/SCS	SABENA
375–376	440-32	N3432/3433	Braniff International Airways
377–380	440-38	N4822C/4825C	Delta Air Lines
381–382	440-12	OO-SCT/SCV	SABENA
383	440-85	N4E	Trans American Aeronautical Corp
384–386	440-32	N3434/3436	Braniff International Airways
387	440-24	N321K	Ford Motor Co
388–389	440-62	PP-YRP/AQB	REAL
390	440-82	N42N	Union Carbide & Carbon
391	440-38	N4826C	Delta Air Lines
392	440-81	I-DOVA	Alitalia
393-397	440-75	OY-KPD/KPE, SE-BSU/BSX, LN-KLA	SAS
398	440-58	YU-ADD	JAT
399	440-83	N98G	Gulf Oil
400	440-40	OH-LRE	Finnair
401-405	440-80	EC-AMR/AMS/ AMT/AMU/AMV	Iberia
406	440-86	N1R	Brooklyn Dodgers
407	440-81	I-DOVE	Alitalia
408–409	440-88	D-ACIB/ ACUM	Lufthansa
410–411	44038	N4827C/4828C	Delta Air Lines
412–414	440-11	HB-IMM/IMN/ IMP	Swissair
415–428	440-86	N9301/9314	Eastern Air Lines
429	440-11	HB-IMR	Swissair
430	440-95	N85U	US Industries
431	440-97	VH-BZF	Ansett Airways
432	440-98	OH-VKM	Kar-Air
433–438	440-86	N9315/9320	Eastern Air Lines
439	440-94	N404M	Martin Co
440–441	440-89	JA5053/5055	All Nippon Airways
442	440-96	SM-1	Italian Air Force (MM 61833)
443–444	440-62	PP-AQC/AQD	REAL
445	440-62		REAL NTU, to N440EL Napier
446	440-62		REAL NTU, to YV-C-EVJ Avensa
447	440-40	OH-LRF	Finnair
448	440-88	D-ACYL	Lufthansa
449–450	440-75		SAS NTU, to VH-BZN/BZO Ansett Airways
451	440-88	D-ACAP	Lufthansa
452	440-63	N7601	Union Oil
453	440-4		Transcontinental SA NTU, to 440-0 N3437 Braniff International Airways
454	440-4		Transcontinental SA NTU, to 440-0 N8445H GD/Canadair
455	440-3	N910BS	Bethlehem Steel
456–457	440-62	PP-AQE/AQF	REAL
458–459	440-97	VH-BZH/BZI	Ansett-ANA
460	440-88	D-ACEX	Lufthansa
461	440-58	YU-ADK	JAT
462	440-0	CF-MKP	Canadair

463	440-75		SAS NTU, to N4405 Mohawk Airlines
464	440-0	D-ABAB	Condor
465	440-97	VH-BZM	Ansett-ANA
466–467	440-59	PP-CEN/CEO	Cruzeiro do Sul
468–469	440-62	PP-YRI/YRJ	REAL
470	440-0	D-ADIL	Condor
471	440-0	PP-CFE	Cruzeiro do Sul
472	440-0	CA+031	Luftwaffe
473	440-3	N920BS	Bethlehem Steel
474	440-0	CA+032	Luftwaffe
475	440-0	CF-LMN	Canadair
476	440-72	57-2552	USAF (C-131E)
477–480	440-72	N101/104	CAA
481–482	440-71	145962/ 145963	USN (R4Y-2)
483–484	440-54		LACSA NTU, to 440-0 N4401/4402 Mohawk Airlines
485	440-0	YV-C-EVD	AVENSA
486–487	440-54		LACSA NTU, to 440-0 N4403/4404 Mohawk Airlines
488	440-0	EC-APY	Iberia
489	440-0	N5121	General Motors
490–492	440-49	PK-GCT/GCU/ GCV	Garuda Indonesian Airways
493–494	440-59	PP-CEP/CER	Cruzeiro do Sul
495	440-0	EC-APZ	Iberia
496	440-4		Transcontinental SA, NTU, to 440-62 N5126 General Motors
497	440-98	OH-VKN	Kar-Air
498–499	440-62	PP-YRK/YRL	REAL
500–501	440-62		REAL NTU, to N5122/5123 General Motors
502–503	440-75	OY-KPF/ SE-BSY	SAS
504	440-62		REAL NTU, to N8470H Hughes Tool
505	440-4		Transcontinental SA, NTU, to 440-75 LN-KLF SAS
506	440-91		R4Y-2T NTU, to 440-75 LN-KLG SAS
507–508	440-91		NTU, to 440-0 N5124/5125 General Motors
509	440-91		NTU, to 440-0 N8860 Sarah Mellon Scaife
510	440-91		NTU, to 440-0 N440M Superior Oil

(Total 199)

Total Convair-production, all models: 1,076

A further ten CL-66Bs (msn 1/10) were built by Canadair at Montreal for the RCAF.

Conversions

Model 540
19, 153, 154, 161, 168, 445, 454, 462, 475

Model 580
2, 4, 7, 8, 11, 12, 13, 14, 15, 16, 17, 18, 19, 22, 23, 24, 25, 28, 29, 30, 33, 34, 35, 38, 39, 41, 42, 43, 46, 49, 50, 51, 52, 53, 54, 55, 56, 57, 60, 61, 62, 65, 67, 68, 69, 70, 72, 77, 78, 79, 80, 81, 82, 83, 85, 86, 89, 94, 98, 100, 101, 109, 110, 111, 114, 115, 116, 119, 121, 126, 127, 128, 129, 130, 132, 135, 137, 141, 145, 147, 150, 151, 154, 155, 157, 160, 161, 163, 168, 169, 170, 176, 179, 180, 186, 202, 214, 217, 220, 221, 245, 312, 318, 326, 327A, 334, 336, 343, 347, 348, 352, 354, 361, 366, 367, 368, 369, 370, 372, 374, 375, 376, 377, 379, 380, 381, 382, 383, 384, 385, 386, 387, 390, 399, 410, 430, 445, 446, 452, 453, 454, 455, 458, 459, 462, 465, 466, 473, 475, 477, 478, 479, 480, 485, 489, 496, 500, 501, 507, 508, 509, 510 plus CC-109s 1, 2, 3, 4, 6, 7, 9, 10.

(Total 170)

Model 600
10, 13, 15, 26, 28, 32, 43, 45, 46, 48, 51, 56, 57, 63, 68, 69, 74, 80, 81, 92, 101, 102, 105, 106, 114, 118, 119, 122, 136, 137, 138, 163, 164, 168, 170, 171, 173, 178

(Total 38)

Model 640
9, 10, 20, 21, 27, 31, 32, 48, 58, 64, 66, 76, 88, 104, 108, 133, 134, 171, 276, 278, 283, 309, 332, 408, 409, 412, 440, 441, 451, 460, 463

(Total 31)

Convair 880 Production

msn	*Model*	*Regn/Initial Operator/Subsequent Regn*
1	22-1	N801TW, N8489H, to 880M prototype, N871TW TWA, N800AJ
2	22-1	N802TW
3	22-1	N803TW, N801AJ
4	22-2	N8801E Delta, AN-BLW, N8801E, N817AJ
5	22-1	N8478H Northeast, N804TW
6	22-1	N805TW, N802AJ
7	22-2	N8802E, N55NW, N880SR
8	22-1	N8479H, Northeast, N806TW, N803AJ
9	22-1	N807TW, N8492H Northeast, AN-BIB, N90452, N818AJ
10	22-1	N808TW, N804AJ
11	22-2	N8803E, N880NW
12	22-1	N8480H Northeast, N809TW, N806AJ
13	22-1	N810TW, N807AJ
14	22-1	N811TW
15	22-1	N812TW, N808AJ
16	22-2	N8804E WO 23/5/60
17	22-2	N8805E, N800NW, N8805E, HH-SMA
18	22-1	N813TW, N8493H Northeast

19	22-1	N814TW, N809AJ	
20	22-1	N8481H Northeast, N815TW, N810AJ	
21	22-2	N8806E	
22	22-1	N8482H Northeast, N816TW, N811AJ	
23	22-1	N8483H Northeast, N817TW, N812AJ	
24	22-1	N818TW, N813AJ	
25	22-1	N819TW	
26	22-1	N820TW WO 13/9/65	
27	22-1	N821TW WO 21/11/67	
28	22-1	N822TW	
29	22-2	N8807E WO 20/12/72	
30	22-1	N823TW	
31	22-1	N824TW	
32	22-1	N825TW, N814AJ	
33	22-1	N826TW	
34	22-1	N8494H Northeast	
35	22-1	N828TW, N815AJ	
36	22-2	N8808E, AN-BLX, N90450, N819AJ	
37M	22-3	N8487H, YV-C-VIC VIASA, VR-HFX WO 5/11/67	
38	22-2	N8809E, N880EP	
39	22-1	N8495H Northeast, AN-BIA, N90455, N820AJ	
40	22-1	N830TW, N816AJ	
41	22-2	N8810E, HP-821, WO 29/3/80	
42	22-1	N801TW	
43M	22-3	N94284, HB-ICL Swissair, N94284, VR-HFT, N48058	
44M	22-4	N8486H, B-1008 CAT, VR-HGA, N48059	
45M	22-3	N94285, HB-ICM, N94285, JA8030 WO 26/8/66	
46M	22-3	N8491H, JA8026, N5858, N54CP	
47M	22-3	VR-HFS, N48060 WO 21/8/76	
48M	22-3	JA8027, N5863, TF-AVB, N5863, N59RD, N5863	
49M	22-3	JA8028 WO 25/6/69	
50	22-2	N8811E	
51	22-2	N8812E, N880WA	
52	22-2	N8813E, HP-876	
53M	22-21	N8490H, YV-C-VIA, VR-HFZ WO 15/6/72	
54M	22-21	N8477H Alaska, VR-HFY, N48062	
55M	22-21	N112 FAA, N42, N84790, BuA 161572	
56M	22-21	N8488H, YV-C-VIB, VR-HGC, N48063	
57M	22-22	JA8021, N5865, N1RN, N5865, WO 16/12/76	
58M	22-22	JA8022, VR-HGF, N88CH	
59M	22-22	JA8023, WO 27/2/65	
60M	22-22	JA8024, VR-HGG, N880JT	
61M	22-22	JA8025, N5866, N4339D	
62	22-2	N8814E, N900NW	
63	22-2	N8815E, N700NW, N8815E WO 25/5/78	
64	22-2	N8816E, YV-145C WO 3/11/80	
65	22-2	N8817E, WO 20/8/77	

2	30-5	N5602, N5602G, OB-R-765 APSA, N990AB	
3	30-5	N5603G, PK-GJA Garuda WO 28/5/68	
4	30-5	N5604G, PK-GJB Garuda, N7876 WO 10/9/73	
5	30-6	N8484H, OB-OAG/OB-R-728 APSA, N990AC	
6	30-6	N8485H, HB-ICF Swissair	
7	30-6	N8497H, HB-ICA Swissair, EC-CNG Spantax	
8	30-6	N8498H, SE-DAY SAS, HB-ICG, EC-CNF	
9	30-5	N5605 American, N8160C	
10	30-5	N5606 American, OD-AEX WO 28/12/68	
11	30-6	N8499H, HB-ICB Swissair	
12A	30-6	HB-ICC Swissair	
13	30-8	PP-VJE VARIG, N987AS, N5603 WO 8/8/70	
14	30-6	HB-ICE Swissair, EC-CNJ	
15	30-6	HB-ICD Swissair WO 21/2/70	
16	30-5	N5607 American, N990E	
17	30-6	SE-DAZ SAS, HS-TGE, HB-ICH, EC-CNH	
18	30-5	N5608 American, OD-AFF, N6844, EC-BZP	
19	30-8	PP-VJF VARIG, N5625, N8258C	
20	30-8	PP-VJG VARIG, N5623, N8259C	
21	30-5	N5609 American, EC-BTE	
22	30-5	N5610 American, EC-BJC	
23	30-5	N5611 American, EC-BJD	
24	30-5	N5612 American, OB-R-925, N5612, N6846, N8357C	
25	30-5	N5613 American, OY-ANI, N5616, OD-AFH, N6845, EC-BZR WO 3/12/72	
26	30-5	N5614 American, OD-AFK, N5614	
27	30-5	N5615 American, N8356C	
28	30-5	N5616 American WO 30/5/63	
29	30-5	N5617 American, N713NA/710NA NASA	
30	30-5	N5618 American, OD-AFG, N6843, EC-BZO	
31	30-5	N5619 American, OD-AEW WO 28/12/68	
32	30-5	N5620 American, EC-BNM WO 5/1/70	
33	30-5	N5601 American, OD-AFJ, N5601	
34	30-5	N5602 American, SE-DDK, N5606, EC-BQQ	
35	30-5	N5603 American, OD-AFI, N2920, EC-BXI	
36	30-5	N5604 American, OY-ANL, N5612, EC-BQA	
37	30-5	PK-GJC Garuda, N7878, N712NA NASA, WO 17/7/85	

Note: msn 38 was completed as 12A and msn 12 was used for static tests.

Convair 990 Production

msn	*Model*	*Regn/Initial Operator/Subsequent Regn*
1	30-5	N5601G, NASA 711/N711NA WO 12/4/73

General Dynamics

The General Dynamics plant at Fort Worth, Texas. To the left is the almost mile-long windowless assembly building. (General Dynamics)

Although General Dynamics had gained control of Convair (or Consolidated Vultee Aircraft as it was still officially known) on 15 May, 1953, for the most part it preferred to continue with the Convair name for public relations and marketing purposes. This changed in May 1961, after Convair was divided into a region of the General Dynamics family. Hereafter, there was little aircraft manufacturing activity at San Diego and that aspect was concentrated at Fort Worth.

The situation at Fort Worth in 1961 was critical, B-58 production was coming to a close and without a major new programme, the factory would have to close. Therefore, it was not altogether a surprise when the TFX (Tactical Fighter) contract was awarded to General Dynamics in November 1962, despite the lower cost of its competitor design submitted by Boeing. To tide Fort Worth over before F-111 production got seriously underway, several conversions of Martin B-57s for the high-altitude reconnaissance role were undertaken. Employment at Fort Worth peaked in 1967 at 28,000, the highest in over ten years. However, the F-111 was surrounded by controversy in its early days and the whole programme was severely curtailed and did not prove to be the bonanza that General Dynamics had hoped for.

In addition to work on the Atlas ICBM, Astronautics began development in 1961 of the Centaur hydrogen-fuelled spacecraft for boosting payloads into orbit. The Pomona Division took over responsibility for the Daingerfield facility in 1965, but the latter was closed four years later. Other missile work included the Advanced Terrier, Standard, Tartar and Redeye, plus the Little Joe II launch vehicle for NASA undertaken by Convair San Diego.

On 22 September, 1970, another reorganisation took place and two new divisions created, Convair Aerospace (formerly Convair and Fort Worth) and Electro Dynamic. The latter was responsible for all tactical missiles, electrical systems and ordnance, with Convair Aerospace concentrating on military and commercial aircraft and space systems. David S Lewis took over as chairman of General Dynamics and Frank Davis became president of Convair Aerospace. Two years later, the headquarters of General Dynamics was moved from New York to St Louis, Missouri. Convair Aerospace underwent another split into two divisions, Convair and Fort Worth, in June 1974, but the basic responsibilities were maintained as before.

The General Dynamics YF-16 had been selected for a 'fly-off' competition against the Northrop YF-17 in 1972, although no commitment for production was made by the Air Force. This changed however, with the possibility of a large order from NATO countries for a new fighter to replace the Lockheed F-104 Starfighter. In order to convince the NATO consortium, consisting of Belgium, Denmark, The Netherlands, and Norway, that the so-called lightweight fighter programme was more than just an exploratory

Much maligned during its development phase and early career, with the help of many upgrades the F-111 is an extremely capable aircraft and will continue in front-line tactical service with the US Air Force well into the 21st century. (General Dynamics)

phase, the US Government decided that the USAF would be enlarged to accept at least 650 of the new fighter aircraft type. Throughout 1974, the prototypes of the YF-16 and YF-17 were thoroughly evaluated and on 14 January, 1975, a Pentagon press conference revealed that the F-16 had been chosen. Although the F-16 was considered superior to its competitor in several respects, the decision was as much a political one. Without the production contract, Fort Worth would have had to close its doors, something which neither the government nor the USAF could allow. In June 1975, the four NATO countries formally announced their selection of the F-16 and a multi-national programme began, with production lines set up at Fort Worth, Amsterdam, and Gosselies in Belgium. Ironically, the F-16 has slowly been transformed from its original role as an air superiority fighter into a heavyweight fighter-bomber, but because of its inherent agility has still maintained its 'dog-fighting' capability.

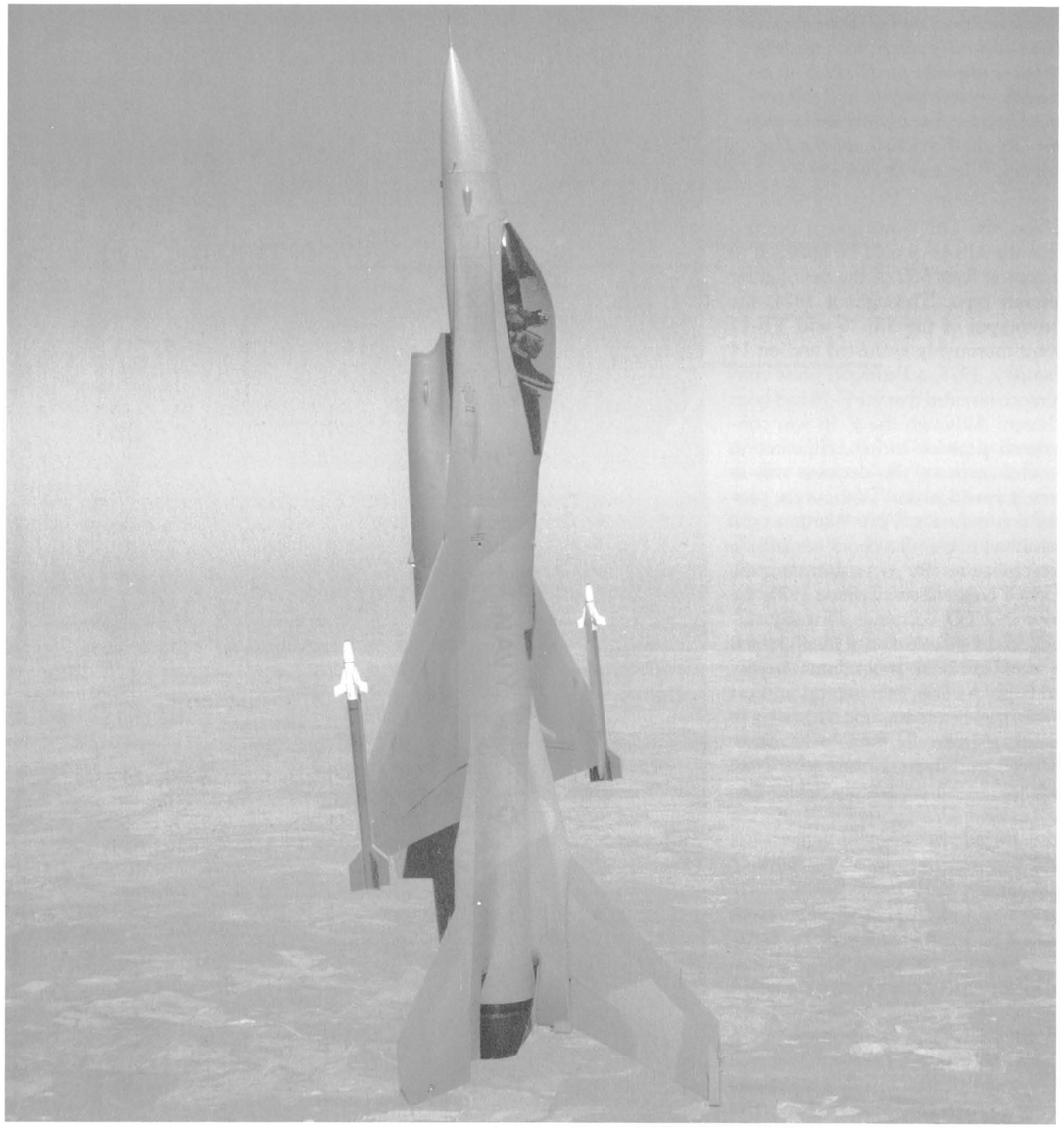
Convair received a contract from Rockwell International's Space Division to build the mid-fuselage section of the Space Shuttle Orbiter Vehicle in 1973. The Canadair Division was sold to the Canadian Government on 5 January, 1976, but the same year, the Tomahawk cruise missile project was started at San Diego for the Navy and USAF.

General Dynamics had talked with Beech Aircraft in 1977 about a possible merger but no further progress was made. Six years later, General Dynamics made a second attempt to re-enter the commercial aircraft field when, in late 1983, it announced a joint advanced technology programme with Cessna Aircraft and acquired 500,000 shares of Cessna stock giving it one seat on the board and a 2.7 per cent share holding. Cessna promptly denied that it was the first step in an acquisition process but in September 1985, General Dynamics launched its bid to obtain ownership of Cessna. On 18 November, 1985, Cessna became a wholly-owned subsidiary of General Dynamics but in January 1986, it was announced that full absorption would be indefinitely postponed. That year, Stanley C Pace replaced Lewis as chief executive officer. William A Anders is scheduled to succeed as chairman and chief executive officer on 1 January 1991.

The Fighting Falcon family. From left, F-16XL, F-16A, F-16C, F-16/79, and AFTI/F-16. (General Dynamics)

General Dynamics in 1990

With annual sales close to $10 billion and a payroll of 106,000, General Dynamics is one of the largest defence contractors in the United States. Military aircraft account for one third of total sales. The remainder comes from missiles, space and electronic systems, submarines, land vehicles and systems, general aviation (Cessna), and other services. In 1986, the company announced that all further growth would be in the defence industry and some non-related subsidiaries were sold.



Now the stock pose for the Fighting Falcon series, a US Navy F-16N (BuA 163268) demonstrates its vertical climb capability over the Texas plains. (General Dynamics)

General Dynamics now consists of ten divisions. The Convair Division; the Electronic Division and the Space Systems Divisions, all located in San Diego; the Pomona and Valley Systems Divisions, close to each other at Pomona and Rancho Cucamonga, California, east of Los Angeles; the Fort Worth Division; the Electric Boat Division, at Groton, Connecticut; the Data Systems Division, at St Louis, Missouri; the Land Systems Division at Troy, Michigan; and the Flight Training Systems Division, at Wichita, Kansas.

Six wholly-owned subsidiaries are the Cessna Aircraft Company, Wichita, Kansas; American Overseas Marine Corporation, Quincy, Massachusetts; Freeman United Coal Mining Company, Chicago; General Dynamics Services Company, St Louis; Marblehead Lime Company, Chicago; and Material Service Corporation, also at Chicago.

The only division building complete aircraft is Fort Worth, now in its second decade of the massive F-16 programme. The F-16 is built on the famous mile-long, windowless assembly line that produced the B-24 during the Second World War. Sixteen countries have ordered the F-16 to date and it is currently being assembled on three foreign production lines with others likely to be added in the future. Confirmed orders now stand at 4,163, but future procurement is likely to bring total production to over 5,000 aircraft including more advanced variants such as the Agile Falcon.

Fort Worth is teamed with Boeing and Lockheed in the Advanced Tactical Fighter (ATF) competition against McDonnell Douglas and Northrop which, if successful, will guarantee Fort Worth's fighter production well into the next century. Two Lockheed/General Dynamics YF-22A prototypes are scheduled for a fly-off against the Northrop/ McDonnell Douglas YF-23A 1991. The USAF expects to acquired 750 aircraft of the winning type from 1993. Fort Worth also operates the Air Force Electronic Warfare Evaluation Simulator and produces radars and avionics. Employment currently stands at around 24,500.

Convair's main activity is the production of Tomahawk cruise missiles and the research and development of follow-on versions. In addition, Convair builds fuselage sections for the McDonnell Douglas MD-11 at Lindbergh Field. At Pomona, production of the Standard missile for the Navy continues. Since 1973, Pomona's Camden, Arkansas, facility has produced Sparrow missiles and up to the end of 1988, nearly 8,000 of this type had been built. Pomona also developed and fabricates the Phalanx gun system for the Navy. Nearby Valley Systems builds the Army's Stinger missile, developed from the earlier Redeye. Space Systems continues work with the Atlas and Centaur vehicles while Electronics develops and manufactures aircraft automatic test equipment. The Electric Boat Division will continue the production of *Ohio* and *Los Angeles* class submarines until the end of the century and is working on the detail design of the *Seawolf* class which it hopes to build. Land Systems ceased production of the M60 tank in 1987 and switched to the M1A1 Abrams battle tank for the US Army. Other research and development work focuses on the Army's Armored Family of Vehicles (AFV) concept and other advanced projects including robotic vehicles.

Of the subsidiary companies, only Cessna is involved in aviation but no longer produces piston-engined types. Instead, the main effort is concentrated on the Citation series of business jets, the Conquest executive-twin and the single-engined Caravan propeller-turbine utility transport.

General Dynamics Aircraft

Fort Worth Division Production Summary

RB-57F		(21)	rebuilt RB-57A, B-57B, RB-57D
F-111A		159	
F-111B		7	completed by Grumman
F-111C		24	
F-111D		96	
F-111E		94	
F-111F		106	
FB-111A		76	
F-111 total		562	
YF-16		2	
F-16A/FSD		6	
F-16B/FSD		2	
F-16A	(USAF)	674	(two built by Fokker, three by SABCA)
F-16A	(Belgium)	136	(SABCA built, completion 1991)
F-16A	(Denmark)	54	(SABCA built)
F-16A	(Netherlands)	167	(Fokker built, completion 1992)
F-16A	(Norway)	60	(Fokker built)
F-16A	(Israel)	67	
F-16A	(Egypt)	39	
F-16A	(Pakistan)	39	
F-16A	(Venezuela)	18	
F-16A	(Singapore)	4	
F-16A	(Indonesia)	8	(delivery 1989–90)
F-16A	(Thailand)	8	(plus eight more by 1991)
F-16A	(Malaysia)	6	
F-16B	(USAF)	121	
F-16B	(Belgium)	24	(SABCA built, completion 1991)
F-16B	(Denmark)	16	(SABCA built, completion 1989)
F-16B	(Netherlands)	36	(Fokker built, completion 1989)
F-16B	(Norway)	14	(Fokker built, completion 1989)
F-16B	(Israel)	8	
F-16B	(Egypt)	9	(one built by Fokker)
F-16B	(Pakistan)	12	
F-16B	(Venezuela)	6	
F-16B	(Singapore)	4	
F-16B	(Indonesia)	4	(delivery 1988–89)
F-16B	(Thailand)	4	
F-16B	(Malaysia)	2	
F-16C	(USAF)	623	(announced serial blocks only)
F-16C	(Israel)	52	(plus second unspecified batch)
F-16C	(Egypt)	34	(plus 34 more for delivery 1990–92)
F-16C	(South Korea)	60	
F-16C	(Turkey)	136	(most TUSAS built, delivery until 1993)
F-16C	(Bahrein)	8	
F-16C	(Greece)	34	
F-16D	(USAF)	88	(announced serial batches)
F-16D	(Israel)	24	(plus unspecified second batch)
F-16D	(Egypt)	6	(plus six, delivery 1990)
F-16D	(South Korea)	12	
F-16D	(Turkey)	24	(most TUSAS -built)
F-16D	(Bahrein)	4	
F-16D	(Greece)	6	
F-16N	(USN)	22	
TF-16N	(USN)	4	
		2,687	(production continues)

WB-57F 63-13501 of the 56th WRS on approach to Yokota AB, Japan. (John Wegg collection)

General Dynamics Aircraft

RB-57F

The English Electric Canberra had been built in the United States under licence by Martin who had developed an increased-span version for high-altitude reconnaissance designated RB-57D. In 1963, the type was grounded following wing structural failures but the USAF had already placed a contract with General Dynamics at Fort Worth for a much more radical conversion for ultra-high altitude operations, designated RB-57F-CF. Two were initially ordered, followed by fifteen more, three from RB-57As and fourteen from B-57Bs.

The conversion work involved almost a complete redesign. A new three-spar 122ft span wing with pronounced dihedral replaced the 64ft span original and featured skin construction of an aluminium honeycomb sandwich. The B-57B's two Wright J65 turbojets were supplanted by two Pratt & Whitney TF33 turbofans, further aided by two J60 turbojets in detachable pods mounted on underwing hardpoints. Ailerons were inset at mid-span, supplemented by spoilers, flaps were eliminated, and all control gaps were tightly sealed to reduce drag. An extended nose housed new radar and a taller tail was fitted. Fuselage fuel tanks were discarded in favour of additional electronic gear and all fuel carried in the wings, outboard of the engines. The plastic wingtips also accommodated electronics and equipment pods could be attached to two other underwing hardpoints. Largely unchanged was the cockpit section, which still accommodated two in tandem. Such was the extent of the rebuild that new serial numbers (63-13286/13302) were allocated and a further four RB-57Ds (63-13500/13503) were similarly modified.

The first RB-57F was flown on 23 June, 1963, and by March 1967, deliveries had been made to the 58th WRS at Kirkland AFB, New Mexico. This unit was followed by the 56th WRS at Yokota AB, Japan. The primary mission was upper air sampling (including intelligence missions following atmospheric nuclear tests) and weather reconnaissance and reporting and eventually all aircraft were redesignated WB-57Fs. However, the type was obviously also suitable for electronic intelligence (ELINT) gathering and other military reconnaissance. The last four aircraft were dedicated to this activity, mostly from bases in Japan and West Germany, for operations close to, and probably over, Soviet bloc countries. However, satellite technology rendered much of this work unnecessary and the type was retired in 1974.

The RB/WB-57F has been used for a great variety of research and experimental tasks in the fields of specialised agricultural and mineral resource photography, satellite calibration, and investigation of weather phenomena. For example, in 1968, an RB-57F from the 56th WRS took part in Operation Cold Cat over Malaysia, an investigation of clear air turbulence.

Three were passed to NASA (NASA 928/925/926 ex-63-13298/13501/13503 respectively) for specialised test work at the Johnson Space Center, Ellington AFB, Texas.

Two Pratt & Whitney 18,000lb st TF33-P-11A turbofans and two auxiliary 3,300lb st Pratt & Whitney J60-P-9 turbojets.

Span 122ft 5in; length 68ft 10in; height 20ft 6in, wing area 1,850sq ft.

Weight empty 36,900lb; normal gross weight 63,000lb (approximate).

Service ceiling 90,000ft, range 4,000 miles (10 hours endurance).

F-111

Certainly one of the most controversial USAF aircraft ever, the first variable-geometry aircraft to enter service anywhere has vindicated itself by proving to be one of the most effective, if not the best, all-weather interdiction aircraft in the world and is now scheduled to remain in front-line service until the year 2010. The furore over the advanced and misleadingly designated design's well-publicised early failures was fuelled by escalating costs and political controversy and of the several thousand aircraft that General Dynamics had hoped to build, only 562 of seven different variants were completed.

In the late 1950s, Tactical Air Command (TAC) had a need for a replacement aircraft for its F-100s, F-101s, and F-105s. Advanced technology then under study, particularly variable-sweep wings, turbofan engines with afterburning, and modular avionics maintenance concepts, was brought together into a Specific Operational Requirement (SOR-183) issued on 14 June, 1960. This called for an attack aircraft with a short and rough field performance, low-level supersonic dash coupled with a Mach 2 plus speed at high altitude, and unrefuelled ferry range to cross the Atlantic or Pacific.

Concurrently, the Navy had a requirement for a new fleet air defence fighter (FAD) to replace the F-4 and F-8 with the capability of loitering on patrol for much longer times with substantially larger missiles. Although some features of the new aircraft would likely be similar, swing-wings, two afterburning turbofans, and two crew members — although the seating arrangement differed between the Services, little else could be similar with the differing missions of low-level strike and high-altitude air-superiority. Nevertheless, at the insistence of Robert S McNamara, Secretary of Defense, the two Services were directed to study development of a single type to be built in two versions with maximum commonality which in theory would reduce procurement costs substantially. Both the USAF and Navy agreed that the joint TFX project, as it was called, was unrealistic, but followed orders and solicited a request for proposals from the industry on 29 September, 1961.

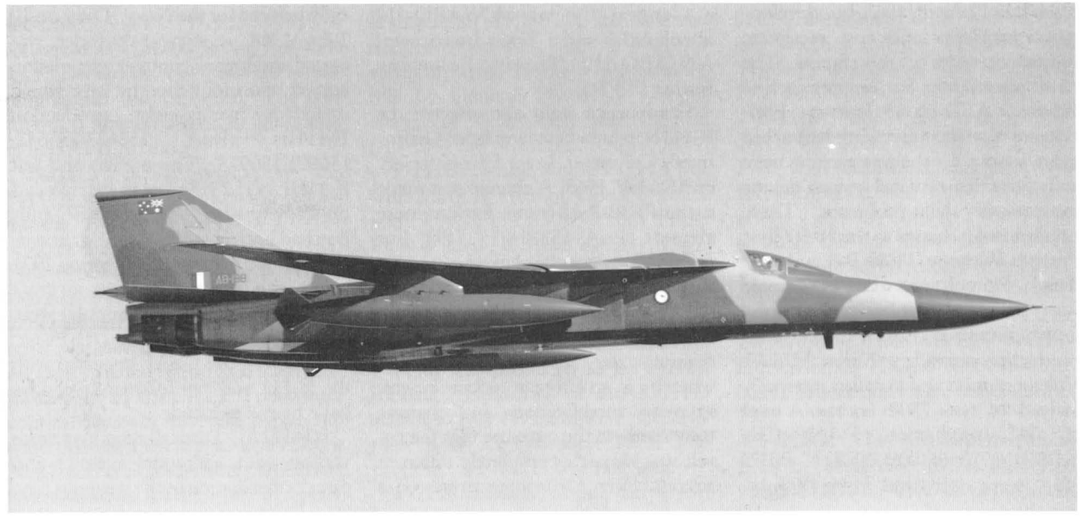
Boeing and General Dynamics were selected as finalists with the former eventually recommended by both Services. Therefore a political uproar ensued when, on 24 November, 1962, the Defense Department announced General Dynamics as the winner, despite its more expensive proposal. No doubt part of the equation in favour of the General Dynamics F-111 was the run down of B-58 production at Fort Worth. Nevertheless, a contract was placed on 21 December for eighteen and five pre-production F-111As (63-9766/9783) and F-111Bs (BuA 151970/ 151974) respectively, the latter the Navy version.

As General Dynamics lacked experience with Naval fighters, it subcontracted Grumman to integrate the Navy electronics and assemble the entire F-111B production aircraft. In addition, Grumman was responsible for producing the aft fuselage section, stabiliser, and undercarriage for all F-111s. The F-111B's nose was 8ft 9in shorter than the F-111A, because of carrier operations, and had 3ft 6in extended wingtips to increase the wing area from 525sq ft to 550sq ft. Armament was to comprise six AIM-54 Phoenix missiles and a Hughes AN/AWG-9 search radar. Otherwise the two aircraft shared the same primary structure, fuel system, two Pratt & Whitney TF30-P-1 turbofans, and two-seat cockpit which doubled as an escape capsule for the side-by-side crew members.

But as a result of the attempt by GD/Grumman to build a single airframe for both Services (which had tipped the scales in their favour), the F-111 ran into immediate problems with weight escalation and high drag. In an effort to correct the former problem, three weight improvement programmes (WIP) were initiated by General Dynamics.

On 21 December, 1964, the first completed F-111A-CF (63-9768) made its maiden flight from Fort Worth with Dick Johnson and Val Prahl. On its second flight, on 6 January, 1965, the wings were swept from the minimum 16 degrees to the full aft 72.5-degree

The only export customer for the F-111 was the Royal Australian Air Force which accepted F-111Cs. (General Dynamics)



Expected to remain based in the United Kingdom until the end of their service life, these F-111Es are part of the 20th TFW, RAF Upper Heyford. That nearest to the camera is assigned to the 79th TFS, with yellow fin tip band. (John Wegg)

Because of its serial number, 366th TFW F-111F 70-2376 was suitably adorned for the US Bicentennial celebrations in 1976.
(Jay L Sherlock)

position. A contract for 431 aircraft was placed on 12 April, 1965, but development problems and cost escalation drastically reduced this figure. The ninth aircraft was lost on approach to Edwards AFB on 19 January, 1967, because of an incorrect wing setting but more serious for the programme were early tests that revealed serious engine compressor stall problems. These necessitated a change to the 18,500lb st Pratt & Whitney TF30-P-3 and new Triple Plow I inlet ducts. Movable wing pylons were introduced by the fourth aircraft and from the eleventh production aircraft, a 20mm M61A1 Vulcan cannon was installed internally instead of two 750lb bombs. A total of 141 production F-111A-CFs (65-5701/5710, 66-0011/0058, 67-0032/0114) were delivered from 17 July, 1967. The standard avionics fit included a General Electric AN/APQ-113 attack radar and a Texas Instrument AN/APQ-110 Terrain Following Radar (TFR).

Compressor stalls also affected the F-111B, which first flew from Grumman's Calverton, Long Island, facility on 18 May, 1965. A change was made to the TF30-P-12 engine for four more aircraft (BuA 152714/152717), but more serious was the alarming increase in weight, from an original 38,800lb empty to over 46,000lb. Already a compromised aircraft for the Navy mission, the situation deteriorated whereby in an effort to reduce weight, so many modifications and changes were made to the airframe that the result was almost a completely different aircraft. Even Grumman proposed a new fighter, the future F-14, specifically tailored for the Navy. Thus, on 10 July, 1968, a stop-work order was issued and formal contract termination agreed upon four months later which included twenty-eight production F-111Bs (BuA 153623/153642, 156971/156978). The seventh and last F-111B (152715) was delivered on 28 February, 1969, after $377 million had been spent on the programme, and flights continued until spring 1971 when the remaining five aircraft (two had been lost in accidents) were permanently grounded.

However, the USAF persisted with the F-111 and the following versions have been produced.

RF-111A: Tactical reconnaissance version with additional avionics and camera installation in the weapons bay,

Not normally noted for their colourful markings, this FB-111A (68-0247) of the 393rd BS, 509th BW, was painted for the 1978 Tiger Meet held at Kleine Brogel, Belgium.
(John Wegg collection)

Finished in a light blue/grey colour scheme, this EF-111A is from the 390th ECS, 366th TFW, Mountain Home, Idaho. (John Wegg)

authorised on 3 December, 1965. One pre-production F-111A (63-9776) was converted as a prototype and first flew on 17 December, 1967, but the whole programme was cancelled. The sole aircraft is now on display at Mountain Home AFB, Idaho.

F-111C: Strike version of the F-111A with eight underwing pylons on the F-111B wing and FB-111 undercarriage; twenty-four (67-125/148) ordered by the RAAF on 24 October, 1963. The first was accepted in September 1968 but then the whole order was stored at Fort Worth pending confirmation of the type's structural integrity by the USAF. Following a political outcry in Australia, the aircraft were delivered from 1 June, 1973, for Nos.1 and 6 Squadrons at Amberley, Queensland (as A8-125/148) to replace interim F-4Es. A proposed conversion of six aircraft to RF-111C standard was not proceeded with, but four F-111As were converted for the reconnaissance role by General Dynamics without change of designation and the first (A8-126) was flown on 27 April, 1979.

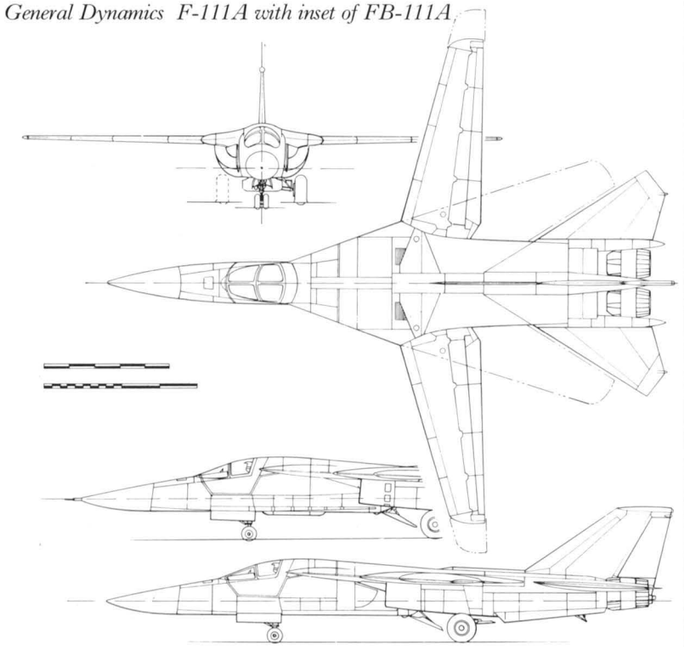
F-111D: Similar to the F-111A but with Mark II microprocessor avionics and 19,600lb st TF30-P-9 with Triple Plow 2 inlets, ordered 10 May, 1967; ninety-six built (68-0085/0180). First flown 15 May, 1970, but development problems with the advanced avionics caused considerable delay and the F-111E was produced as an interim measure. Deliveries of the F-111D started in July 1971 and were not complete until 28 February, 1973. The proposed RF-111D was not built.

F-111E: Because of late delivery of the F-111D, ninety-four 111Es (67-0115/0124, 68-0001/0084) with simplified avionics and the TF30-P-3 but Triple Plow 2 intakes were ordered in 1968 and delivered by May 1971.

F-111F: The final version produced for TAC ordered on 1 July, 1970, with all airframe changes, Mark IIB simplified but more advanced avionics and 25,100lb st TF30-P-100 although the first thirty had TF30-P-9s and were subsequently re-engined; 106 built (70-2362/2419, 71-0883/0894, 72-1441/1452, 73-0707/0718, 74-0177/0188) and another twenty-four cancelled 71-0895/0906, 75-0210/0221). Production ended in September 1976.

F-111G: The fifty-one remaining SA-FB-111As are to be converted into F-111Gs for TAC for deployment

General Dynamics F-111A with inset of FB-111A



in the United Kingdom from June 1990. Changes include modification for conventional tactical weapons delivery although the ability to launch cruise missiles will be retained. The first conversion was completed at McClellan AFB Sacramento, California, in spring 1989.

F-111K: Strike/reconnaissance variant for the RAF; forty-six ordered 1 February, 1967 (67-0153/0158, 68-0181/0210, 68-0229/0238 assigned XV902/947) but cancelled in January 1968. The first two were in an advanced state of assembly and reallocated as research and development aircraft for the USAF as YF-111As (67-0149/ 0150). However, they were not completed. In addition, four TF-111K operational trainers were ordered (67-0149/0152 assigned XV884/ 887) but also cancelled.

FB-111A: First announced on 10 December, 1965, the FB-111A was a B-52 and B-58 interim successor for SAC with 12,500lb st TF30-P-7s, F-111B wings, a fuselage lengthened by 2ft for extra fuel, and strengthened undercarriage. Two AGM-69As short-range attack missiles (SRAMs) could be carried in the internal weapons bay along with two more on underwing pylons and four 600US gal drop tanks to increase unrefuelled range to 6,150 miles. Alternatively, up to twenty-four 750lb bombs could be carried externally, or six gravity nuclear weapons or a B77 nuclear bomb. Of the 263 originally intended, production was cut to 76 on 19 March, 1969 (67-0159/0163, 67-7192/7196, 68-0239/0292, 69-6503/6514). One pre-production F-111A (63-9783) was converted as a prototype and first flown on 30 July, 1967. The first production aircraft followed on 13 July, 1968, and was fitted, like the second aircraft, with a TF30-P-12 engine.

EF-111A Raven: An electronic counter measures (ECM) version of the F-111 was first proposed in 1970 to replace the Douglas EB-66 and at one time consideration was given to converting the twenty-four F-111Cs stored for the RAAF. On 30 January, 1975, Grumman was authorised as prime contractor to complete two prototypes converted from F-111As. The first (66-0049) was flown from Calverton, Long Island, on 15 December, 1975, with a 16ft long canoe-shaped radome underneath the fuselage to house the Raytheon AN/ALQ-99E tactical radar jamming subsystem and a fin-tip pod to accommodate the ECM receivers. The cockpit was re-arranged with the omission of the second set of aircraft controls for the occupant of the right-hand seat, now an electronics warfare officer (EWO), and the addition of various displays for the latter. Empty weight was increased to 55,275lb but the maximum take-off weight remained the same as for the F-111A as there was no weapon capability.

The second (66-0041) was first flown on 17 May, 1977, with full electronics. Further conversion of another forty F-111As was approved in 1979 with the name Raven and the first prototype was brought up to this standard and flown on 26 June, 1981. An update of the AN/ALQ-99E by the AIL Division of Eaton Corporation was cancelled in May 1988 because of cost overruns and a modification solution was still pending at the end of the year.

In addition, a number of versions were proposed for SAC but cancelled. The FB-111B/C announced in 1979 was to have had a fuselage lengthened to 88ft 2½ in, F101-GE-102 turbofans, Boeing SRAM-As on underwing pylons and a gross weight of 140,000lb; 155 were planned for conversion from F-111Ds and FB-111As. In order to compete with the B-1 in 1970, the FB-111G had a 104in fuselage stretch and a load of four SRAMs. Rejected in 1971, the designation was revived four years later to cover a modified version with eight SRAMs. In 1977, again to compete with the B-1, the FB-111H was offered with the fuselage of the FB-111B/C, advanced avionics, F101-GE turbofans, six underwing stores pylons and an enlarged bomb-bay for twelve SRAMs. A modified version would have had a 10ft fuselage stretch, twelve cruise missiles on wing pylons plus four SRAMs carried internally.

Deliveries of F-111As to a TAC unit began in October 1967 to the 474th TFW at Cannon AFB, New Mexico (later Nellis AFB, Nevada). The following March, six aircraft of the 428th TFS were assigned to Takhli AB for combat trials over North Vietnam under the code name *Combat Lancer*. Three were lost through a failure of a welded joint in the tailplane control system, but the others proved the F-111's undetectable interdiction capability but were returned to the USA after only fifty-five missions. Soon after, cracks were discovered in the steel swing-wing pivot boxes and all

F-111A 68-0269 of the 509th BW, Pease AFB, New Hampshire.
(John Wegg)

FB-111A 68-0244 of the 380th BW, Plattsburgh, New York.
(John Wegg collection)

F-111s were flight restricted. However, on 22 December, 1969, an F-111A pulling out of a low-level attack lost its port wing. As a result, all aircraft were grounded until July 1970 and underwent a complete inspection which cleared the type. In fact, the F-111 had experienced the lowest accident record of any USAF supersonic aircraft.

A second deployment to Takhli began on 27 September, 1972, with the arrival of the 429th and 430th TFS from Nellis. This time the F-111A performed brilliantly, flying 4,030 sorties mostly at night and in poor weather at low altitude thanks to the TFR and achieving high accuracy against very heavily defended targets with the AN/APQ-113 attack radar and AJQ-20 inertial bombing-navigation system. After the ceasefire in February 1973, further missions were flown against targets in Laos by 'Aardvarks', a nickname applied to the F-111 by crews. Four were lost in combat over Vietnam, and another over Laos.

Surviving F-111As were transferred to the 366th TFW at Mountain Home, Idaho, in 1977. Subsequently, forty-two were converted into EF-111As and two squadrons remain, possibly to be replaced by F-15E Strike Eagles in the 1990s. Four were transferred to the RAAF in 1982 to cover attrition.

The Triple Plow 2 intake modification was introduced on the F-111E and after initial delivery to the 27th TFW, Cannon AFB, New Mexico, in late 1969, most aircraft were assigned to the 20th TFW at Upper Heyford in England. The first arrived on 12 September, 1970.

In 1971, the 27th TFW at Cannon AFB started to receive F-111Ds but it did not become fully operational until two years later. Deliveries of the F-111F began in September 1971 to the 347th TFW (later 366th TFW) at Mountain Home and in 1976, following attacks on American personnel, were deployed to Taegu AB, Korea. All were re-assigned to the 48th TFW at Lakenheath, England, six years later. The *Pave Tack* precision weapons guidance system was tested on an F-111F during 1978 and first became operational with the 494th TFS on 15 September, 1981. On 14/15 April, 1986, it was put to operational use when eighteen F-111Fs with 2,000lb bombs attacked Tripoli, Libya, in an 6,300-mile round-trip operation coded *El Dorado Canyon*. One aircraft was lost.

Supporting this mission were three EF-111A 'Spark Varks' from the 42nd ECS, 66th ECW at Upper Heyford. This had been the second Raven unit activated in February 1984, following the initial delivery to the 388th ECS, Mountain Home, on 5 November, 1981, for training purposes. This latter unit was deactivated and the Raven entered service with the 390th ECS on 14 December, 1982.

Deliveries of the FB-111A to SAC began on 8 October, 1969, to the 4007th CCTS, 340 BG, at Carswell. The first operational wing was the 509th BW, Pease AFB, New Hampshire, equipped in 1971. This was followed by the 380th BW, Plattsburgh, New York, the next year, but the type was not declared fully operational until 1973. The sixty surviving aircraft are scheduled for transfer to TAC from 1990 as F-111Gs as the B-1B becomes operational.

One of the pre-production F-111As (63-9777) was used for tests by NASA and another (63-9778) became the Transonic Aircraft Technology testbed. Fitted with a supercritical wing of shorter span with blunt wingtips and reduced aspect ratio under a joint NASA/USAF programme, the F-111/TACT first flew at Edwards AFB on 1 November, 1974. During mid-1980, it was flown with laminar-flow glove-sections on the wing then

In 1975, the first YF-16 conducted a European tour. At RAF Alconbury in June, 72-01567 still carries Paris Air Show number 53 on the engine intake, along with markings showing the number of demonstration flights. (John Wegg)

rebuilt with a Boeing variable-camber 'mission adaptive' wing for Advanced Fighter Technology Integration tests. First flown by Lt-Col Frank Birk and Rogers Smith on 18 October, 1985, the F-111/ AFTI continued further flight testing until early 1989 when it was retired to the USAF Museum.

General Dynamics Fort Worth undertakes complete rebuilds of F-111s following accidents in order to maintain sufficient aircraft number levels. At McClellan AFB, the Air Force Logistics Center undertakes extensive maintenance of the fleet including avionics and systems updates and testing. In 1987, work began on updating twenty-one FB-111As from Pease AFB, New Hampshire, through an Avionics Modernization Program (AMP), and all had been completed by March 1988. Further deliveries of AMP FB-111As will continue until April 1990. The AMP kits, designed by Grumman and TRW, will also be installed in one hundred and fifty-seven F-111As, F-111Es, and EF-111As. The kits include improved TFR, INS and global positioning system, digital cockpit displays, and upgraded communications sets. Aircraft are also 're-lifed' by British Aerospace at Filton near Bristol.

F-111F

Two 25,100lb st (with afterburner) Pratt & Whitney TF30-P-100 turbofans.

Span 63ft 0in (16-degree sweep), 32ft 0in (72.5-degree sweep); length 73ft 6in (without probe); height 17ft 0in; wing area 525sq ft.

Weight empty 46,172lb; gross weight 82,819lb; maximum gross weight 98,950lb.

Maximum speed 1,453mph at 53,450ft, 914mph at sea level; cruising speed 1,194mph; climb 25,550ft/min; service ceiling 56,650ft; combat radius 1,330 miles; ferry range 3,634 miles (5,043–7,443US gal fuel capacity).

FB-111A

Two 20,350lb st (with afterburner) Pratt & Whitney TF30-P-7 turbofans.

Span 70ft 0in (16-degree sweep), 34ft 0in (72.5-degree sweep); length 75ft 6¼ in (with probe); height 17ft 0in; wing area 550sq ft.

Weight empty 47,481lb; gross weight 110,646lb; maximum gross weight 114,277lb.

Maximum speed 1,453mph at 50,000ft; 838mph at sea level; cruising speed 151mph; climb 23,418ft/min; service ceiling 50,263ft; combat range 6,160 miles (with refuelling); unrefuelled ferry range 4,786 miles (5,010–9,223US gal fuel capacity with six 600US gal drop tanks).

Model 401 F-16 Fighting Falcon

Unquestionably one of the most significant fighter aircraft of the latter part of this century and one that will continue to play a major role well into the next, incongruously the F-16 developed from an experimental concept of a lightweight fighter (LWF) into an all-weather air combat fighter and precision attack bomber aircraft. The USAF has planned to acquire over 2,700 aircraft and overseas orders already stand at close to 1,400 with substantial follow-on orders likely. Already built on four production lines, a fifth is planned to start production in the mid-1990s, making the F-16 the largest fighter programme in the western world.

The Model 401 designation covered a wide range of advanced fighter designs, studied at Fort Worth from 1965. With the USAF selection of the McDonnell Douglas F-15 Eagle, studies concentrated on an LWF or LCF (Low Cost Fighter) concept for daytime dogfighting in visual conditions with rudimentary air-to-air electronics. Funding was authorised for two prototypes of two different designs to compete in a 300-hour fly-off programme, the first in almost 20 years, at Edwards AFB. Six manufacturers submitted proposals in February 1972, all based on the two most important considerations of turning radius and acceleration in the transonic zone. General Dynamic's Model 401-16B and Northrop's P-600 were chosen for development two months later and contracts for two YF-16s (72-01567/01568) and two YF-17s respectively were placed.

Designed and built at Fort Worth under the direction of William C Dietz and Lyman C Josephs, with Harry Hillaker as chief designer, the first YF-16 was rolled out on 13 December 1973, just 21 months after the contract had been placed. This rapid progress was the result of a lack of a detailed specification. The new aircraft incorporated four major advanced technology features, a computer-controlled variable-camber wing with flaperons, blended wing-body design, the use of vortex lift from forebody wing strakes, and a 'relaxed' static stability/fly-by-wire (RSS/ FBW) control system, the first time this feature had been planned from the outset for any aircraft. An unusual design feature was the lower intake location for the single 23,500lb st Pratt & Whitney F100-PW-100 engine and, as the wing was far too thin, the nosewheel undercarriage was fuselage mounted. The airframe was predominantly constructed of aluminium, with small amounts of steel, titanium, and composite materials.

Also important were a number of elements designed to aid the pilot for up to 9g combat (with full internal fuel), a side-stick console control layout, an ejector seat tilted 30 degrees, and an all-around vision bubble canopy.

Substantial weight savings were realised by the new design, which offered a thrust to weight ratio of 1.4 to 1, and costs were reduced by using interchangeable tailplanes, and flaperons. Much of the undercarriage structure was also common to either side. The YF-16s also incorporated a host of accessories from other types in production or service and were designed for a service life of 8,000 hours, double the usual. Avionics were simple and armament comprised one 20mm M-61 rotary cannon and two AIM-9 Sidewinder missiles and stores on two external hardpoints.

General Dynamics, although not assured of a production contract, put maximum effort into the programme right from the beginning. In addition to the preliminary USAF requirement for 350 aircraft, the Navy was interested in up to 800 and four NATO air forces were searching for a Lockheed F-104 Starfighter replacement.

The four models of the Fighting Falcon currently in USAF service, from rear the F-16A, F-16B, F-16C, and F-16D. All are from the 58th TFTW, Luke AFB, Arizona. (General Dynamics)

For the Navy requirement, General Dynamics teamed with Ling-Temco-Vought (LTV) to propose three models, the 1600 with a Pratt & Whitney F401 engine, the 1601 with an F100, and the 1602 with an F101. However, as both manufacturers resided in the same state, there was little likelihood of receiving a contract and the Navy, after considerable procrastination, went on to buy an improved version of the YF-17, the Northrop/McDonnell Douglas F-18 Hornet.

The first YF-16 made an unplanned six-minute flight at Edwards AFB on 21 January, 1974, in the hands of Phil Oestricher after minor damage to the tailplane, suffered in high-speed taxiing trials, caused a violent lateral rocking. An official 90 minute maiden flight was made on 2 February. The second aircraft was flown for the first time on 9 May.

Up to then, the LWF programme was largely seen as an academic exercise. But Defense Secretary James R Schlesinger changed direction and announced that a multi-role derivative design, known as the Air Combat Fighter (ACF), would be acquired to complement, rather than supplement the F-15. In fact, this move was to assure the potential NATO customers that the United States stood firmly committed to the new fighter. In October, the USAF announced plans to buy 650 ACFs and the possibility this could be increased to 1,400 aircraft.

With the air combat radius, speed, altitude performance, and fuel consumption of the YF-16 cited as superior to the YF-17, there was little surprise when the official announcement was made on 13 January, 1975, in favour of General Dynamics. There was certainly political influence in the decision as well, as Fort Worth, with the F-111 programme coming to a close, needed the F-16 to remain in business.

A contract was placed for fifteen full-scale development (FSD) aircraft, including four two-seat versions. The major changes for the production aircraft, designated F-16A, were a 13in fuselage extension to accommodate more fuel and a Westinghouse APG-65 radar to replace the General Electric version, the increase to nine external stores points with a total capacity of 10,000lb of fuel or weapons, an arresting hook, a larger tailplane and

Caught in typical NATO weather, this Fokker-built F-16B is from 332 Skv, Royal Norwegian Air Force, Rygge. A drag chute is housed in the fairing at the base of the vertical fin. (John Wegg)

increased wing area, speed brakes, and the replacement of the Escapac ejector seat with an Aces II model. The two-seater, the F-16B, was originally proposed with a 30 $^{1}/_{2}$in fuselage extension, but this change was cancelled in favour of discarding internal fuel tanks. However, full weapons capability was retained.

The need for FSD aircraft dropped to six F-16As (75-0745/ 0750) and two F-16Bs (75-0751/0752) and all had the F100-PW-100 (3) engine. The first F-16A/FSD was flown on 8 December, 1976, by Neil R Anderson, and he and Oestricher made the first flight of the F-16B on 8 August the following year.

Meanwhile, Belgium, Denmark, The Netherlands, and Norway had formed the Multinational Fighter Programme Group to choose a successor to the Lockheed F-104G. Although matched against the Northrop P-530 Cobra, Dassault Mirage F.1, and SAAB Eurofighter (JA37 Viggen), there was little competition as in its new form the F-16 offered more new technology, superior performance, and an attractive offset production package. Thus, despite criticism concerning its vulnerability, lack of beyond-visual-range and all-weather capability, and the poor performance of the F100 engine, on 7 June, 1975, the four countries announced plans to buy 348 F-16s. Production was divided between SONACA/SABCA in Belgium and Fokker in The Netherlands. Inevitably, there were early problems with two more production lines but these were overcome and besides airframe assembly, Fokker builds centre sections and other assemblies for US production and SONACA /SABCA produces wings and other parts. From this point the programme has continued with the following production versions.

F-16A: As described above with APG-65 radar and first flown (78-0001) on 7 August, 1978, by Neil Anderson. Multinational Staged Improvement Program (MSIP) Stage I Block 15 modifications (introduced on 330th aircraft, October 1981) include structural strengthening to allow an extra 1,000lb on wing points, new wiring for longer-range missiles, notably the Hughes AMRAAM (AIM-120), provision for new avionics and APG-66 (later -66A) radar, and simplified, larger tailplane with 30 per cent increase in area. A programme to upgrade systems and avionics of all Block 1/5, code named *Pacer Loft 1*, was introduced in 1982. A second *Pacer Loft* upgrade started December 1983.

Production for the USAF until March 1985 totalled 674 (78-0001/ 0076, 79-0288/0409, 80-0474/0622, 81-0663/0811, 82-0900/1025,83-1066/ 1117). Of these, two (82-0966/0974) were built by Fokker and three by SABCA.

SABCA built ninety-six for the Belgian Air Force (FA-01/96 msn 6H-1/96 allotted 78-0116/0161, 80-3538/3587) at Gosselies and delivered the last on 28 April, 1985, this being the final aircraft of the original 348 NATO order. A second order for forty will not be completed until 1991 (FA-97/136 allotted 86-0073/0077, 87-0046/0056, 88-0038/0047, 89-0001/ 0011, 90-0025/0027). A further forty-six were built for Denmark (E-174/203 msn 6F-1/30 allotted 78-0174/0203, E-596/611 msn 6F-31/46 allotted 80-3596/3611). Eight more followed from late 1987 (E-004/008, allotted 87-0004/0008, E-016/018, allotted 88-0016/0018).

The Netherlands received an initial batch of eighty built by Fokker (J-212/258 msn 6D-1/47 allotted 78-0212/0258, J-616/648 msn 6D-48/80 allotted 80-3616/3648). Orders have since been increased to a total of 167 for delivery until March 1992 (J-864/881 msn 6D-81/98 allotted 81-0864/0881, J-192/207 allotted 83-1192/1207, J-358/367 msn 6D-115/124 allotted 84-1358/1367, J-135/146 allotted 85-0135/0146, J-054/063 allotted 86-0054/0063, J-508/514 allotted 87-0057/0066, J-001/012 allotted 88-0001/0012, and J-013/021 allotted 89-0013/0021. A further twenty are likely to be ordered to cover attrition up to the year 2020.

The last twenty of the initial order were designated F-16A(R), capable of carrying an Oude Delft Orpheus sensor pod on the centreline pylon. This variant was first flown on 27 January, 1983. Fokker also built sixty for Norway (272/300 msn 6K-1/29 allotted 78-0272/0300, 658/688 msn 6K-30/60 allotted 80-3658/3688) and the last was flown on 10 May, 1984.

In December 1984, Fokker delivered two additional aircraft to the USAF as recorded above and built two more for Pakistan.

At Fort Worth, production for export orders up to mid-1988 has been sixty-seven for Israel (msn 6V-1/67 ex-78-0308/0354, 80-0649/0668); thirty-nine for Egypt (9301/9334 ex-80-0639/0643, 81-0643/0660, 81-1061, 82-1056/1065); twenty-eight for Pakistan (81-0899/0926) including two built by Fokker, plus a second batch of eleven; eighteen for Venezuela (82-1050/1052, 83-1186/1188, 84-1346/1357); eight for Thailand; and four for Singapore (87-0397/0400).

Further orders are for eight for Indonesia (delivery 1989–90); eight for Thailand (delivery by 1991); twelve for Singapore (delivery 1990–91), and six for Malaysia.

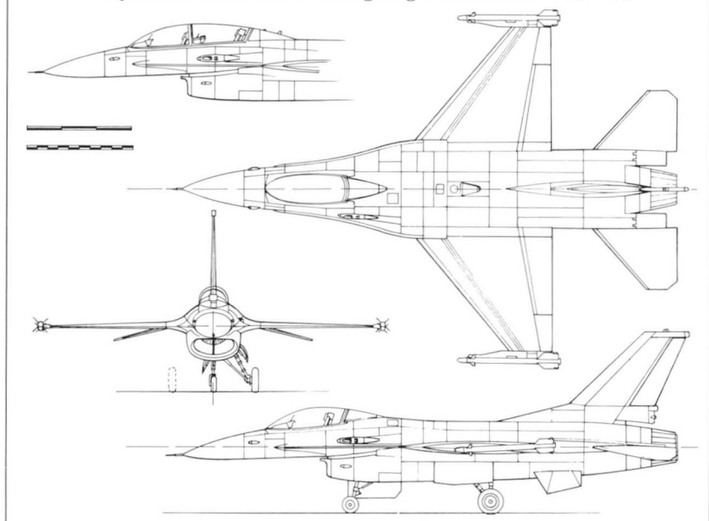
A Block 10/15 operational capability upgrade (OCU) programme for USAF and NATO aircraft began in 1987 and will run until 1991. Improvements include increased avionics computer capability, improved radar software, mission data system, advanced weapons capability, and low altitude warning system.

F-16B: Tandem two-seat trainer version as described earlier, with similar upgrades to F-16A and internal fuel reduced from 6,972lb to 5,875lb. Production for USAF totalled 121 (78-0077/0115, 79-0410/0432, 80-0623/ 0638, 81-0812/0822, 82-1026/ 1049, 83-1166/1173).

SABCA built twenty for Belgium (FB-01/20 msn 6J-1/20 allotted 78-0162/0173, 80-3588/3595) and will deliver another four (FB-21/24 allotted 87-0001, 88-0098/0099, 89-0012) by 1991. The first aircraft (FB-01), also the first European-built F-16, made its first flight on 11 December, 1978, with Serge Martin and Anderson. Twelve were built for Denmark (ET-204/211 msn 6G-1/8 allotted 78-0204/0211, ET-612/615 msn 6G-9/12 allotted 80-3612/3615) and four more are scheduled for completion by 1989 (ET-197/199 allotted 86-0197/0199, ET-022 allotted 87-0022).

Fokker completed an initial batch of twenty-two for The Netherlands (J-259/271 msn 6E-1/13 allotted 78-0259/0271, J-649/657 msn 6E-14/22 allotted 80-3649/3657) and will continue production until 1992. Fourteen additional aircraft are confirmed (J-882, J-884/885 allotted 81-0882, 0884/0885, J-208/211 allotted 83-1208/1211, J-368/369 msn 6E-31/32 allotted 84-1368/1369, J-064/065 allotted 86-0064/0065, J-515/516 allotted 87-0515/0516, plus one other for delivery 1989). The first (J-259) was flown on 3 May, 1979. In addition, one aircraft (81-0883) was delivered to Egypt and twelve for Norway (301/307 msn 6L-1/7 allotted 78-0301/0307, 689/693 msn 6L-8/12 allotted 80-3689/3693). Two others for Norway were delivered in 1989. Two of the original batch for The Netherlands were completed as F-16B(R)s.

General Dynamics Model 401 F-16 Fighting Falcon with F-16B inset



Exports from Fort Worth include eight for Israel (msn 6W-1/8 allotted 78-0355/0362); nine for Egypt (9201/9209 allotted 80-0644/0648, 81-0662, 81-0883 — Fokker-built, 81-1061, 82-1043); twelve for Pakistan (81-0931/0938, 81-1504/1507, including four built by Fokker); six for Venezuela (82-1053/1055, 83-1189/1191); four to Singapore (87-0401/ 0404); and four to Thailand. Future deliveries will include four to Indonesia and two for Malaysia.

F-16C: As the early F-16s were not all-weather capable, a deficiency particularly obvious in Europe, MSIP Stage II improvements (Block 25) included an APG-68 radar, Marconi wide-angle raster-video HUD (Warhud); advanced cockpit and increased computer capacity for all-weather capabilities, and the Martin Marietta LANTIRN system (Low Altitude Navigation Targeting for Infra Red at Night). This version was redesignated F-16C in 1981, the only external difference being an expanded tail root fairing housing an ALQ-165 jamming system. The first F-16C or Block 25 aircraft (83-1118) was flown on 19 June, 1984, and delivered exactly one month later and the new variant introduced on the production line from that December.

Under the Alternate Fighter Engine (AFE) programme, confirmed in 1984, the USAF also adopted the F110-GE-100 engine for the F-16 and the first delivery of an F-16C with this powerplant was made in July 1984. Following initial deliveries to overseas units the 61st TFTS, 56th TFW, at MacDill AFB, Florida, became the first continental USA-based squadron to receive the type in April 1986, becoming operational in October 1988.

Block 30/32 (produced from January 1986, deliveries started July 1987) introduced the *Seek Talk* secure voice communication system, AGM-65D Maverick missile capability, and from mid-1987, the -220 version of the F100 for those so-equipped aircraft; Block 40, referred to as the 'Night Falcon' introduced in December 1988, stresses the F-16 to 9g fully combat loaded and has further system upgrades to improve all-weather capability. From mid-1991, Block 50 aircraft will have a 29,000lb class of engine, and further radar, systems, and maintenance improvements. The last Block 50 aircraft would be delivered in 1997 if all planned 2,737 USAF aircraft (this figure includes two-seaters) are acquired. Serial batches for 623 have so far been released (83-1118/1165, 84-1212/1318, 84-1374/1395, 85-1398/1505, 85-1544/ 1570, 86-0207/ 0371, 87-0217/0362).

The Nato countries have not produced or ordered this version but export orders have been fifty-two F-16C-30s for Israel with F110-GE-100 engines (86-1598/1612, 87-1661/ 1693, 88-1709/1711) and an as yet unconfirmed number of -40s for

The F16XL large wing concept could still form the basis of a new generation F-16. Note the stylised cockpit painted underneath this F-16XL/B (75-747) to confuse opposing pilots with regard to its turning direction. (General Dynamics)

delivery from 1991; thirty-four for Egypt with the F100-PW-220 (9501/9508 ex-84-1332/1339, 85-1518/1543) plus another thirty-four for delivery in 1990-92; twenty-four for South Korea with the F100-PW-220 (85-1574/1583, 86-1586/1597, 87-1653/1654) plus thirty-six more for delivery from late 1988 and additional orders are being considered with assembly likely by Samsung Aerospace; 136 for Turkey (including 86-0066/0069, 88-0034/0037, 89-0022/0041, 90-0001/0021, 91-0001/0021, 92-0001/0021, 93-0001/0014) with the majority assembled at Murted by TUSAS Aerospace Industries; eight for Bahrein; and thirty-four for Greece with F110- GE-100s for delivery by 1990.

F-16D: Two-seat version of F-16C with similar upgrade programme and planned deliveries to 1997; serials for eighty-eight have been released (83-1174/1185, 84-1319/1331, 84-1396/1397, 85-1506/1517, 86-0039/0053, 87-0363/0396). From FY85 batches, both the F110-GE-100 and the F100-PW-200 are installed.

Export orders: twenty-four F-16D-30s for Israel with the F110-GE (87-1694/1708, 88-1712/1720) and an unconfirmed number of F-16D-40s to be delivered from 1991; six for Egypt with the F100-PW-220 (84-1340/1345) plus another six on order for delivery in 1990; twelve for South Korea with the F100-PW-220 (including 84-1370/1373, 85-1384/1385); twenty-four for Turkey with the F110-GE-100 (86-0191/0196, 87-02/0003, 88-0013/0015, 89-0042/0045, 90-0022/0024, 91-0022/0024, 92-0022/0024), most assembled by TUSAS at Murted; four for Bahrein; and six for Greece with F110-GE-100s.

F-16G: Originally used for a reconnaissance version, this designation was later applied to a proposed version of the F-16A for Greece. However, the differentiating equipment was not acquired and the Greek order was changed to the F-16C.

F-16N: Adversary training version of F-16C for the US Navy, ordered in January 1985 with F110-GE-100 engines, twenty-two delivered from 17 June, 1987 (BuA 163268/163277 allotted 85-1369/1378, BuA 163566/163577 allotted 86-1684/1695). Four aircraft were delivered as two-seat TF-16Ns (F-16D equivalent) from March 1988 (BuA 163278/163281, allotted 85-1379/1382). No gun, global positioning system, (GPS), airborne self-protection jammer (ASPJ), or underwing pylons are provided for either model.

In addition, there have been a number of company-sponsored projects and proposed variants as follows.

F-16/79: In an attempt to provide a cheaper and politically more acceptable export version, one of the F-16B/FSDs (75-0752) was modified with an 18,370lb st J79-GE-17X turbojet which offered better acceleration but less overall performance. In this form, it was first flown on 29 October, 1980, by James A McKinney. Although offered to several countries including Austria and Singapore, and the US Navy as an adversary trainer, no orders were received. Production aircraft would have had the -119 engine.

F-16/101: Under a joint USAF/Navy project to evaluate an alternative engine to the F100 (which experienced problems both in the F-16 and F-14), the first F-16A/FSD (75-0745) was fitted with a 29,000lb st General Electric F101X (designed for the cancelled B-1A). First flown on 19 December, 1980, at Edwards AFB by David Palmer, the derivative F110-GE was adopted for F-16C/D production.

F-16CM: An unsolicited 1985 proposal to the USAF, the F-16CM was a less expensive version of the F-16C/D to block possible F-20 acquisition, optimised for the air-to-ground role. None were built.

F-16B/F100-229: In May 1989, the USAF started a four-month programme at Edwards AFB to flight-test the improved Pratt & Whitney F100-229 engine, flown in an F-15 during 1988, which is intended for future F-16 production.

F-16XL, F-16E, F-16F: In an effort to gain the USAF contract for an advanced air-to-air and air-to-ground fighter (won by the F-15E Strike Eagle), two F-16/FSDs were modified with a cranked-arrow wing, double the area of the standard F-16, to increase fuel capacity and provide supersonic cruise capability. The first F-16XL/A SCAMP (Supersonic Cruise Aircraft Modification Program) aircraft (75-0749) with a F100-PW-102 engine flew on 3 July, 1982, with James McKinney. The second, a two-seater designated F-16XL/B (75-0747) was first flown on 29 October, 1982, by Alex Wolfe and McKinney, and had an F101-GE engine. Production aircraft (F-16E) would have been two-seaters with a two-plug fuselage stretch for additional fuel. In 1984, the single-seat variant has revived as the F-16F to offer greater combat flexibility but was cancelled in November the following year. In late 1988, following storage at Fort Worth, the two prototypes were acquired by NASA for the three or four-year programme to evaluate concepts designed to improve sustained supersonic flight. The first, the single-seat F-16XL, was re-flown on 9 March, 1989, and delivered to the Ames-Dryden Flight Research Facility, Edwards AFB. The second F-16XL is assigned to NASA's Langley Research Center, Hampton, Virginia.

The F-16/CCV (72-01567) at Fort Worth in 1976. (General Dynamics)

F-16R/RF-16: The long-proposed reconnaissance version of the F-16 was originally referred to as the F-16G, then F-16R. In September 1984, a contract was placed for the conversion of one F-16D (84-1330) as a risk-reduction test-bed for the centreline mounted ATARS (Advanced Tactical Air Reconnaissance System) pod with electro-optical instead of film-based sensors. Tested at Edwards during 1986, 250 conversions are scheduled from existing Block 30 aircraft for TAC from 1991, with deliveries during 1992-97 as RF-16s to replace RF-4Cs.

A-16: First proposed in 1986, this is an optimised close-support version with FLIR, Laser Spot Seeker, Digital Terrain System, wide-angle HUD, 30mm gun pod, increased chaff/flare dispensers, and structural improvements. The USAF had hoped to replace its A-10s from 1991, but budgetary restraints have deferred the A-16 and instead improvements will be made to both F-16s and A-10s for the close air support mission. This was expected to replace A-10s from 1991, but political pressure has forced a fly-off between the A-10, A-7F, and AV-8B in 1990.

F-16/CCV: One YF-16A (72-01567) was modified in 1976 for use as the Control Configured Vehicle for a programme conducted by the Flight Dynamics Laboratory, AFSC. Two 8sq ft canards were added under the fuselage air intake which added side forces, enabling the aircraft to change direction without banking or changing heading. First flown on 26 March, 1976, the programme was completed in June 1977 after a nine-month break following a landing accident a year before and is currently continued by the AFTI/F-16.

AFTI/F-16: One of the F-16A/FSDs (75/0750) was returned to the manufacturer on 6 March, 1980, and modified as an Advanced Fighter Technology Integration test-bed (designated NF-16A) under a joint USAF/Navy/NASA programme to explore advanced manoeuvring concepts started by the F-16/CCV and new weapons delivery techniques. With canards taken from the F-16/CCV, the AFTI/F-16 was first flown on 10 July, 1982, at Fort Worth by Alex V Wolfe, then moved to Edwards. A triplex digital flight control system provides six independent degrees of freedom and a voice command system with a dictionary of fifty words was installed. Phase I testing was completed on 30 July, 1983, and the following year Phase II testing started with a dummy, then operational FLIR mounted on the wing root, F-16C standard avionics, and an Automated Manoeuvering Attack System (AMAS). In spring 1988, the AFTI began a close air support research programme with a Collins CP-1516 Automatic Target Hand-Off System (ATHS).

F-16 Agile Falcon: Studied since 1984, this is an upgraded version of the F-16C/D with increased wing-span and area and use of advanced composite materials to counter the threat of modern Soviet fighters such as the

Royal Thai Air Force F-16A 88-6378/0305 before delivery in 1988. (General Dynamics)

MiG-29 and Su-29. NATO interest has been lukewarm and in mid-1989, it appeared that an upgraded F-16, but not necessarily in Agile Falcon configuration, would eventually be chosen. However, other countries, such as Israel, South Korea, and Turkey remain interested. Approximately five hundred of the 878 already planned, but not yet ordered, USAF F-16s could be completed to this standard. However, no decision has yet been taken although an upgraded F-16 is scheduled for development in 1991-92 to complement the Advanced Tactical Fighter (ATF) in the air superiority role. The derivative F-16 would probably adapt ATF engines and avionics.

Other publicised but still-born F-16 proposals include the F-16/FSW Forward Swept Wing demonstrator; the E-7 with a delta wing and thrust augmenting ejectors for V/STOL operations studied in 1982; the Specially Configured F-16C for air-defence; and the FX-4, a twin- engined version designed to meet the Japanese FS-X requirement but abandoned in 1987 in favour of the F-16C because of the high cost.

Although not yet acknowledged by the company, reports indicate that a version of the F-16 is being designed for production in Taiwan.

In order to test the feasibility of the F-16 for *Wild Weasel* suppression duties, one F-16B/FSD (75-0752, later the F-16/79 prototype) was fitted with wingtip receiver pods, a centreline ALQ-119 ECM pod, two AGM-78F Standard and two AGM-45 Shrike missiles. No further activity has taken place.

The USAF accepted its first F-16 on 17 August, 1978, and on the following 6 January, initial operational deliveries were made to the 388th TFW, Hill AFB, Utah, for training of both USAF and NATO crews. The 56th TFW, at MacDill AFB, Florida, was assigned the role of operational training and the first deliveries were made on 19 October, 1979. The first overseas deployment was to the 8th TFW, Kunsan AB, South Korea, in September 1981, followed by the 50th TFW at Hahn, West Germany, in December. The PACAF currently has two F-16 wings of two squadrons each (the other being the 432nd TFW at Misawa AB, Japan) and the USAFE four wings, three in West Germany and one in Spain, with the latter scheduled to move to Italy in 1990.

Despite a movement favouring Condor (the pilots preferred Viper), the name Fighting Falcon was announced on 20 July, 1980, the prefix necessary to avoid litigation by Dassault and Falcon Jet Corp, and confusion with the Falcon missile. The common nickname used by pilots is 'Electric Jet' in a reference to the fly-by-wire system.

Despite impressive performances during overseas deployments in 1981 to Bergen, Norway, and Lossiemouth, Scotland, the F-16 has suffered its fair share of development problems. Restricted use of the gun was in force from September 1979 to April 1980 because of interference to the flight control system and failures of the latter have occurred that rendered the F-16 uncontrollable. Problems have also been experienced with the F100 engine and after successful tests with the F-16/101, this led to the alternative engine programme with the F110-GE for the F-16C/D series. However, this engine has also experienced some difficulties.

In March 1982, the USAF announced that F-16A/Bs would be supplied to ANG and AFRES squadrons. The first ANG unit, the 157th TFS at McEntire ANGB, South Carolina, was officially declared active on 15 July, 1983, followed by the first AFRES squadron, the 466th TFS at Hill in January 1984. In 1983, the USAF demonstration team, the *Thunderbirds*, re-equipped with the type and first deliveries of the improved F-16C were made to the 58th TFTW, Shaw AFB, South Carolina, in July 1984.

On 6 September, 1986, the first ANG squadron, the 159th FIS at Jacksonville, Florida, was activated for the air defence role with F-16As replacing F-106s. The following month, it was announced that the F-16A was winner of the Continental Air Defense competition over the Northrop F-20A Tigershark, to replace the F-106 and F-4 with twelve Air National Guard squadrons. A contract was placed for kits to update and modify 270 F-16As at the Ogden Air Logistics Center, Utah, with HF radio, improved APG-66 radar, identification spotlight and a radar-guided missile capability using

The first F-16B for Singapore prior to delivery. (General Dynamics)

AIM-7 Sparrow and Hughes AIM-120 missiles. The first delivery was scheduled for February 1989. This version is the first to have full 'beyond visual range' capability and earlier export F-16A/Bs and F-16C/Ds are likely to undergo the same modifications. The first delivery (F-16B 82-1041) was made to the Oregon ANG in April 1989.

Early in 1989, F-16C/Ds started to replace Northrop F-5s with USAF aggressor squadrons, starting with the 64th and 65th Aggressor Squadrons at Nellis AFB, Nevada, for use in dissimilar combat training exercises such as Red Flag. Aircraft will also be based at RAF Bentwaters, Kadena AB, Okinawa, and Tyndall AFB, Florida. Also in 1989, it was planned to modify two squadrons of F-16s based at Misawa AB, Japan, to carry Harpoon anti-ship missiles to complement Boeing B-52s operating in the Pacific area.

As of mid-1987, the planned buy of F-16s for the USAF was 2,737 of which 1,859 are to be delivered by May 1991.

The Navy received the first of its F-16Ns on 17 June, 1987, for use as air combat adversary trainers to enable more accurate representation of modern Soviet equipment. Eight and six aircraft were delivered to the Top Gun unit and VF-126, respectively, both at Miramar, California; and from October 1987, twelve to VF-45 at NAS Key West, Florida, for a total of twenty-six.

Confirmed overseas sales approached 1,400 (mid-1988) and are briefly described in order sequence.

Belgium: The initial order covered 116 SABCA-built aircraft (96 F-16As and 20 F-16Bs) and the first (an F-16B) was delivered on 26 January, 1979. The type became operational with 349 Sm, No.1 Wing at Beauvechain in January 1981. Further deliveries were made to 350 Sm (also Beauvechain), 23 and 31 Sm, No. 10 Wing (Kleine-Brogel), and 1 and 2 Sm, No.2 Wing, at Florennes, following an order for forty-four more aircraft (forty F-16As, four F-16Bs). Force Aérienne Belge aircraft also carry the Matra Magic missiles.

Netherlands: The Koninklijke Luchtmacht received the first (F-16B J-259) of an initial batch of eighty F-16As and twenty-two F-16Bs on 6 June, 1979. The first of eight squadrons was No.322 at Leeuwarden AB, declared operational on 1 May, 1981, and followed by Nos. 323 (also Leeuwarden); 306, 311 and 312 (at Volkel); 315 and 313 (at Twenthe), and 316 at Eindhoven (subject to further purchases) in that order. A further eighty-seven F-16As and fourteen F-16Bs have been confirmed with the last scheduled for delivery in March 1992. In 1989, the USAF announced it would transfer twenty F-16A/Bs to the Netherlands to replace lost aircraft. All twenty-two F-16A(R)s were delivered to No.306 Sqdn and the F-16 is expected to remain in service until 2020.

Norway: The Kongelige Norske Luftforsvaret ordered sixty F-16As and 12 F-16Bs and the first delivery (an F-16B) was made on 25 January, 1980. The OCU was Skv 332 at Rygge, with the first operational unit, Skv 331 at Bodø, later joined by Skv 334 (at Bodø) and 338 at Orland, the last handed over on 4 June, 1984. All aircraft are fitted with a drag chute in a fairing at the base of the rudder and can carry the Penguin anti-ship missile. Two further F-16Bs were delivered in 1989 and eight F-16 delivered in 1990 to replace losses.

Denmark: The initial order was for forty-six F-16As and twelve F-16Bs with the first delivery (F-16B ET-204) to the Kongelige Danske Flyvevabnet made on 28 January, 1980. All F-16s went initially to Esk 727 at Skrydstrup which acted as a holding unit. Second to start equipping was Esk 730 in October 1981, also at Skrydstrup, then Esk 723 at Åalborg. An additional eight F-16As and four F-16Bs were ordered in August 1984, to allow a fourth unit, Esk 726 to be equipped, and the final aircraft, an F-16B (ET-022 for Esk 727) was delivered on 15 September, 1988.

Iran: Under the code name *Peace Zebra*, a letter of intent for 160 aircraft was signed on 27 October, 1976, and was expected to increase to 300 with deliveries from 1978. The Imperial Iranian Air Force order was cancelled following the 1978 revolution and fifty-five aircraft were diverted to Israel.

Israel: An order for sixty-seven F-16As and eight F-16Bs was announced on 15 August, 1978, under the *Peace Marble* programme, a major factor being the early delivery of aircraft intended for Iran. The first delivery was an F-16B (003) on 31 January, 1980, which then went to Hill

AFB, Utah. The first four aircraft were ferried to Israel on 2 July, 1980, by USAF pilots on an eleven-hour non-stop flight from Pease AFB, New Hampshire. All seventy-five had been delivered by 30 October, 1981. Later aircraft were fitted with Israeli Elta 2021B radar.

A second order for another seventy-five was not announced, but embargoed following the occupation of Lebanon. In 1983, the order was approved for fifty-two F-16C-30s and twenty-four F-16D-30s (F110-GE) with Israeli-built avionics, computer and weapons systems and deliveries began in November 1986, with the first three F-16Cs arriving at Ramat-David AB on 9 February, 1987. Some of the comparatively large batch of F-16Ds are thought to have been converted for ECM aircraft escort duties and for the role of missile sight suppression. Israeli F-16s also carry the indigenous Rafael Python 3 air-to-air missile.

A third batch of seventy-five (Block 40 F-16C/D aircraft) was approved in 1988 as compensation for the Lavi cancellation. Delivery will start in May 1991 and these will have Israeli avionics and electrical systems installed.

On 7 June, 1981, the Fighting Falcon lived up to its name by going into combat for the first time. Operating from Etzion AB, eight Heyl ha'Avir F-16A/Bs, loaded with a pair of 2,000lb bombs each, attacked and destroyed the Osirak nuclear reactor in Iraq. Israeli F-16s were also used over Lebanon in June 1982 during Operation Peace for Galilee and shot down forty-four enemy aircraft.

Egypt: An order for forty aircraft was signed in June 1980 as part of project *Peace Vector*. However, actual deliveries comprised thirty-nine F-16As and nine F-16Bs (including one built by Fokker). The first was handed over on 15 January, 1982, and deliveries were made from March until mid-1984 to two squadrons of the 232 Tactical Fighter Brigade at Inchas.

A second order for thirty-four F-16Cs and six F-16Ds (F100-PW-200) was approved early in 1982, completed by late 1985 but not handed over until August 1986 under the *Peace Vector II* programme. From October 1986, these aircraft were delivered to two squadrons at Beni Suef.

A third order was placed in October 1987 for thirty-four F-16Cs and six F-16Ds (F110-GE), with delivery from 1990. Al Quwwat al Jawwiya ilMisriya F-16C/Ds do not have Hughes AMRAAM capability.

South Korea: In August 1981, approval was received and subsequently twenty-four F-16Cs and six F-16Ds (F100-PW-220) were delivered from March 1986, and became operational at Kunsan AB in October 1987. A follow-on batch of thirty F-16Cs and six F-16Ds was delivered by the end of 1988, and more orders are expected for the Han-guk Kong Goon (RoKAF) with assembly likely by Samsung Aerospace.

Pakistan: Twenty-eight F-16As and twelve F-16Bs (including two SABCA-built F-16As and four F-16Bs built by Fokker) were ordered in October 1981 and the first was handed over a year later on 13 October. Deliveries were made to Nos.11 and 9 Squadrons at Sargodha AB, Islamabad, from December until March 1986. A further batch of eleven to cover attrition was authorised in April 1988 and sixty more will be delivered from September 1992. Aircraft of the Pakistan Fiza'ya have engaged in successful combat with Afghan Soviet-built fighters along its disputed borders.

Venezuela: An order for eighteen F-16As and six F-16Bs, all fitted with drag parachutes was authorised in 1981 with the first handover at Fort Worth in September 1983. Deliveries were made to the Fuerzas Aéreas Venezolanas' 16th Group at El Libertador AB, Palo Negro-Maracay, from November until April 1985.

Turkey: One hundred and sixty (136 F-16Cs and twenty-four F-16Ds with F110-GE-100s) were ordered for the Türk Hava Kuvvetleri in September 1983. Eight aircraft were built at Fort Worth and the remainder will be completed by TUSAS Aerospace Industries at Murted by 1994. The first delivery (F-16D 86-0191) was made at Fort Worth on 17 July, 1987, and the first TUSAS-built F-16C flew in October 1987 and was delivered on 31 November. Initial deliveries will be made to Nos.141 and 142 Filo at Murted.

Thailand: Sixteen F-16C/Ds were requested in 1983, but eight F-16As and four F-16Bs were confirmed in April 1985, with the first delivery made at Fort Worth in May 1988. All twelve aircraft had arrived at Korat AB by October. A further eight F-16As were ordered in July 1987 for the Royal Thai Air Force, for delivery by 1991.

Greece: A decision to acquire thirty-four F-16Cs and six F-16Ds with F110-GE-100 engines was made in November 1984 following a drawn out selection process, but the formal agreement was not signed until 12 January, 1987. Formal delivery of the first aircraft (F-16D '144') to the Helliniki Aeroporia was made on 18 November, 1988, and all had been delivered by October 1989 to form three squadrons at Nea Ankhiatos AB. An option for twenty more aircraft remains.

Singapore: Four F-16As and four F-16Bs with the J79-GE-119 engine were initially approved for the Republic of Singapore Air Force but at the customer's request this was changed to the F100-PW-220 and announced in January 1985. The first delivery (of an F-16B, the 2,000th F-16) was made on 10 February, 1988, but all aircraft remained at Luke AFB, Arizona, until late 1989. These are the first foreign aircraft to incorporate Operational Capabilities Upgrade (OCU) enhancements. Options are also held on twelve more.

Indonesia: An order for four F-16As and four F-16Bs was announced in spring 1986, but frozen over the question of offsets. In August 1986, it was revised to eight F-16As and four F-16Bs for the TNI-AU (Tenatara Nasional Indonesia-Angkatan Udara), with delivery in 1988–89. Some components, including wing flaperons and vertical fin skins, are built by IPTN and AIM-9P4 missiles will be carried.

Bahrain: An order for eight F-16Cs and four F-16Ds (F110-GE-100) was announced in March 1987. Deliveries to the Bahrain Imiri Air Force started in 1988 and another four aircraft have been requested.

Japan: Long interested in the F-16, in October 1987 Japan decided to use the F-16C as the basis for a Fighter Support-Experimental (FS-X) close-support aircraft, also once known as the 'SX-3'. After a congressional battle over transfer of US advanced technology to Japan, approval was won in May 1989, and 130 are expected to be built by Mitsubishi Heavy Industries at

A standard F-16A, the F-16/101 demonstrator, and the F-16/79 demonstrator (an F-16B) fly over the desert near Edwards AFB. (General Dynamics)

Nagoya (in co-operation with General Dynamics and other US suppliers) by 2001 to replace its F-1 and F-4EJ aircraft with the Nihon Koku Jieitai (Japanese Air Self-Defence Force). A number of structural changes will be made to the F-16C airframe, including a longer rear fuselage, a modified nose, and Agile Falcon-type wings of increased area. Ventral canards will be added below the engine inlets to increase manoeuvrability and there will be greater use of advanced technology composite materials, including radar-absorbent materials, and Japanese-developed equipment, including an active phased radar array. Either the General Electric F110-GE-129 or Pratt & Whitney F100-PW-229 engine will be selected. Assembly of six prototypes is scheduled to start in 1991, with a first flight two years later and production deliveries from late 1997, but development by the Japanese of computer software could delay this timetable by up to two years.

Malaysia: Eight aircraft (six F-16As and two F-16Bs) were approved in June 1988 for the Tentera Udara Diraja Malasia (Royal Malaysian Air Force). Four more are on opotion.

Portugal: As part of the military and economic assistance package negotiated in February 1989 for the continued use of Lajes AB, Azores, the USAF has agreed to supply the Forca Aérea Portuguesa with twenty F-16A/Bs.

A Falcon Century programme maintains a master plan for F-16 developments into the next century and there is little doubt that F-16 derivatives will still be in service 50 years after the first flight of the prototype.

F-16A-1-CF

One 23,840lb st Pratt & Whitney F100-PW-200 turbofan with afterburner.

Armament: One General Electric M61A1 20mm Vulcan cannon and two AIM-9J/L Sidewinder missiles mounted on wingtip rails. Six underwing hardpoints and centreline position can accommodate up to 12,000lb of fuel tanks, ECM pods, bombs and other stores.

Span 31ft 0in; length 49ft 3in; height 16ft 8½in in wing area 300sq ft.

Weight empty 14,567lb; gross weight 35,400lb.

Maximum speed 1,350mph at 40,000ft (Mach 2.05); 915mph at sea level (Mach 1.2); service ceiling 50,000ft plus; combat radius 575 miles; ferry range (with drop tanks) 2,415 miles.

F-16C-30-CF

One 25,000lb st Pratt & Whitney F100-PW-200 or 27,000lb st General Electric F110-GE-220 turbofan with afterburner.

Weight empty 16,794lb; gross weight 26,100lb.

General Dynamics Selected Projects

Model 200

Study for supersonic VTOL single-seat fighter as back-up to North American XFV-12A and AV-16 Advanced Harrier, 1971–74, double-delta wing with controlled canard, for operation from Sea Control Ship concept, two Rolls-Royce/Allison XJ99 lift engines and Pratt & Whitney F401-PW-400 cruise engine with nozzle. The Model 201 was a conventional take-off and landing version.

Model 210

Cessna T-37 replacement design for NGT (New Generation Trainer) programme in 1981.

Model 603E

T-tailed, tandem seat, twin-engined jet trainer for Navy VTXTS competition in 1980. The Navy's choice was the British Aerospace Hawk.

STAT

Under a NASA-funded Small Transport Aircraft Technology study in

1980, General Dynamics/Convair designed a 30-passenger, high-lift-wing twin-engined and T-tailed commuter. The pusher engines were beneath the tailplane.

X-30 National Aero-Space Plane (NASP)

General Dynamics, along with McDonnell Douglas and Rockwell International, received a contract to develop a transport able to cruise at Mach 12 or more in space orbit but take-off and land from conventional runways, designated X-30. Early in 1990, the three airframe contractors, along with Rockwell's Rocketdyne Division and Pratt & Whitney, agreed to establish a National Contractor Team to finalise a joint design. Construction could start in 1993, but the project is threatened with delays or cancellation because of budget restraints.

YF-22A

A team consisting of Boeing, General Dynamics, and Lockheed (prime contractor) is expected to fly a YF-22A Advanced Tactical Fighter (ATF) prototype, powered by a General Electric YF-120 engine, in April 1990. Designed to replace the F-15 Eagle, the YF-22A will compete for the USAF and possibly a US Navy contract with the YF-23A developed by Northrop and McDonnell Douglas.

A-12

General Dynamics and McDonnell Douglas were selected in 1987 to develop an Advanced Tactical Aircraft (ATA), designated A-12, intended as a replacement for the Navy's A-6 Intruder from the early 19902s. Powered by derivatives of the General Electric F404 engine, the twin-engined A-12 also replaceUSAF F-111s.

T-48

This designation covers a proposal for an improved Cessna T-37 trainer offered as a co-development project with South Korea which wishes to produce an indigenous primary jet trainer. The T-48 would be part of a work sharing programme in connection with South Korea's FX fighter project.

Index of Aircraft Types

This cross-referenced list includes all manufacturers' models, all military designations (including prefixes), and official and unofficial names for ease of checking and locating types. However, civil and military suffix designations are not listed separately unless they distinguish a different type covered under another model. For example, L-13A will be found under L-13, but B-36G is listed because it was redesignated YB-60. Page numbers in italics refer to illustrations only.

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